U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-266 573

Proposed Steam Electric Power Plant, George Neal Steam Electric Station, Neal Unit No. 4, Port Neal Industrial District, Salix, Woodbury County, Iowa. Appendix

Environmental Protection Agency, Kansas City, Mo.

Prepared for

Army Engineer District, Omaha, Nebr.

Jan 77

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5. REPORT DATE
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Region VII

8. PERFORMING ORGANIZATION REPORT NO.

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1735 Baltimore
Kansas City, Missouri 64108

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1735 Baltimore
Kansas City, Missouri 64108

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907/00

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16. ABSTRACT

The U.S. Environmental Protection Agency (EPA) has prepared the statement for the coal-fired, 576 megawatt power plant near Sioux City, Iowa in conjunction with the U.S. Army Corps of Engineers (Corps) and the Rural Electrification Administration (REA). EPA was responsible as lead agency in the project as a result of the plant's need for a new source National Pollutant Discharge Elimination System permit required under Section 402, Public Law 92-500. The Corps' responsibility in the project was pursuant to the project's requirement for Section 404, P.L. 92-500 and Section 10, River and Harbor Act permits. REA was involved with the project as a result of its possible issuances of loan guarantees to local electricity cooperatives. The statement includes analyses of expected impacts upon air and water quality, water quantity, noise levels, land use and aesthetics resulting from construction and operation of the proposed station. Energy source, plant siting, facility design and operation alternatives are described. (Portions of this document are not fully legible).

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FEIS-004
NPDES Permit Number: IA0061859
January 1977

FINAL

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX

for

PROPOSED STEAM ELECTRIC POWER PLANT
GEORGE NEAL STEAM ELECTRIC STATION
NEAL UNIT #4
PORT NEAL INDUSTRIAL DISTRICT
SALIX, WOODBURY COUNTY, IOWA

prepared by

U.S. ENVIRONMENTAL PROTECTION AGENCY

REGION VII

KANSAS CITY, MISSOURI

in conjunction with

U.S. ARMY ENGINEER DISTRICT
OMAHA, NEBRASKA
and
RURAL ELECTRIFICATION ADMINISTRATION
WASHINGTON, D.C.

with the assistance of

Envirosphere Company
A Division of Ebasco Services, Inc.
New York, New York

Approved by:

Charles V. Wright
Charles V. Wright
Acting Regional Administrator

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SUMMARY

GEORGE NEAL UNIT 4 STEAM-ELECTRIC GENERATING STATION

( ) DRAFT (X) FINAL

Responsible Office: U.S. Environmental Protection Agency, 1735 Baltimore, Kansas City, Missouri 64108, telephone 816-374-2921.

1. Type of Action: (X) Administrative ( ) Legislative

2. Description of Action: Iowa Public Service Company of Sioux City, Iowa, has applied for a new source National Pollutant Discharge Elimination System permit for the operation of a 576 megawatt coal-fired steam-electric generating facility adjacent to the Missouri River. The station is located approximately 14 miles south of Sioux City, Iowa.

Pursuant to the National Environmental Policy Act of 1969 (PL 91-190), EPA has prepared this final Environmental Impact Statement (EIS) to evaluate the potential environmental impacts of this action upon the Missouri River, Woodbury County, and the surrounding area.

This EIS is a multiagency document, and will serve as the U.S. Army Corps of Engineers' EIS on their possible issuance of a Section 404, Federal Water Pollution Control Act Amendments permit and a Section 10, River and Harbor Act permit. The Iowa Public Service Company has applied for a Department of the Army permit under Section 10 of the River and Harbor Act of 3 March 1899 (30 Stat 1151; 33 U.S.C. 403) and under the provisions of Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (86 Stat 816; 33 U.S.C. 1344) for activities related to the proposed construction of an intake pumphouse, outfall structure, and armored riprap apron for a 576 megawatt coal-fired steam-electric power generating facility on and in the Missouri River at mile 716.64L (1960 mileage). The work will consist of constructing a coffer cell retaining structure, dewatering the work area, excavating approximately 21,800 cubic yards of material, constructing the intake and outfall structures, placing the required backfill, repairing the bank revetment, removing the coffer cell retaining structure, installing approximately 300 linear feet of sheet piling, and placing approximately 1,500 cubic yards of armor riprap aprons in front of the intake and outfall structures. The intake pumps will extract river water at a rate of approximately 707 cubic feet per second for use as condenser coolant in the power generating plant and will be returned to the river through the discharge structure. The statement will also serve as the EIS for the Rural Electrification Administration's possible issuance of a loan guarantee to Cornbelt Power and Northeast Iowa Power Cooperatives to provide for generating facilities and related transmission facilities.

3. Environmental Impacts: The power plant will convert approximately 450 acres of agricultural land and wildlife habitat to industrial use. Combustion for power generation will result in the release of waste by-products into the atmosphere and heated discharge water into the Missouri River. Approximately 50 million tons of coal will be committed during the 30-year life of the facility. The facility is expected to provide for the production and distribution of power to meet present and projected demands. The total cost of the project is estimated at $276 million. Liquid discharges will be those associated with coal pile runoff, plant wastewater treatment systems and sanitary waste treatment systems.

Adverse Environmental Effects: Construction of the station will, to varying degrees, disrupt aquatic and terrestrial habitats. Noise and dust will also result from construction activities. Damage or death of aquatic organisms will result from their impingement on the intake structure and entrainment into the circulating water system during plant operation. The levels of certain air pollutants (e.g., sulfur dioxide, nitrogen oxides, and particulates) are expected to increase.

4. Alternatives: Denial of permit, resulting in no discharge; alternate plant sites; alternate cooling systems; alternate fuels; alternate routes of fuel transportation; alternate methods for the treatment of stack emissions; and alternate ash disposal techniques.

5. Comments Requested:

Federal Agencies

Council on Environmental Quality
U.S. Department of Agriculture
    Forest Service
    Soil Conservation Service
U.S. Department of Commerce
    National Marine Fisheries Service
U.S. Department of Health, Education, and Welfare
U.S. Department of Housing and Urban Development
    Regional Administrator, Region VII
    Area Director
U.S. Department of the Interior
    Special Assistant to the Secretary
    Fish and Wildlife Service
    Bureau of Land Management
    Bureau of Mines
    Bureau of Reclamation

  - Bureau of Indian Affairs
  - Bureau of Outdoor Recreation
  - National Park Service
  - Office of Land Use and Water Planning
  - Geological Survey
- U.S. Department of Transportation
  - Federal Highway Administration
  - Coast Guard
  - Federal Aviation Administration
- Federal Power Commission
- National Bureau of Standards
- Advisory Council on Historic Preservation
- Water Resources Council
- Federal Energy Administration
- Missouri River Basin Commission

Members of Congress

Richard C. Clark, U.S. Senate
John C. Culver, U.S. Senate
Berkley Bedell, U.S. House of Representatives

State

Iowa "A-95" Coordinator, Governor's Office
Nebraska "A-95" Coordinator, Governor's Office
Lyle Scheelhaase, State Representative
Donald V. Doyle, State Representative
Willis Junker, State Representative
Leonard Anderson, State Senator
E. Kevin Kelly, State Senator
Iowa Department of Environmental Quality
State Library Commission of Iowa

Local and Regional

Mayor, Salix, Iowa
Mayor, Sioux City, Iowa
Woodbury County Conservation Board
Sioux City Public Library

Interested Groups and Individuals

People's Energy Project
Wildlife Society, Iowa Chapter
American Fisheries Society, Iowa Chapter
Audubon Society of Iowa
Sierra Club, Sioux City Chapter
Citizens for Environmental Action
Citizens United for Responsible Energy
Iowa Association of Municipal Utilities
J.N. "Ding" Darling Foundation, Inc.
Izaak Walton League, Sioux City Chapter
Keep Earth's Environment Pure

Nature Conservancy, Iowa Chapter
State Preserves Board
Ducks Unlimited
Iowa Wildlife Federation
Iowa Commercial Fisheries Association
Iowa Ornithologists' Union
Iowa Citizens for Environmental Quality

6. The draft Environmental Impact Statement was sent to Council on Environmental Quality in October 1976.

7. The final Environmental Impact Statement was sent to Council on Environmental Quality in January 1977.

Section A - II - B

This section contains initial quality data on the coal for Neal Unit 4. This supplements information provided in Section II-B of the Environmental Impact Statement.

ROCKY MOUNTAIN ENERGY COMPANY - RED RIM

QUALITY REPORTS BY SEAM

DATA PROCESSING BY COMPUTING ASSOCIATES, INC

TUCSON, ARIZONA

SEAM B

Drillhole	Btu/lb	Sulfur	Moisture	Ash	Volatile	Carbon	Grind	Lbs Ash/ 10-6 Btu	Equivalent Moisture
RR 55	8507	0.42	24.44	7.90	30.59	37.07	-	9.29	-
RR 81	7322	0.36	21.98	19.60	27.47	31.15	-	26.50	-
RR 92	8194	0.30	27.00	6.12	29.26	37.62	-	7.47	-
RR 105	8288	0.58	25.05	8.65	31.71	34.79	-	10.20	-
Averages	8078	0.41	24.62	10.47	29.76	35.16	-	13.36	-
Low	7322	0.30	21.98	6.12	27.47	31.15	-	7.47	-
High	8507	0.58	27.00	19.60	31.71	37.62	-	26.50	-
Sigma	-	-	-	-	-	-	-	-	-
Conf (95)	-	-	-	-	-	-	-	-	-

ROCKY MOUNTAIN ENERGY COMPANY - RED RIM

QUALITY REPORTS BY SEAM

DATA PROCESSING BY COMPUTING ASSOCIATES, INC

TUCSON, ARIZONA

SEAM C

Drillhole	Btu/lb	Sulfur	Moisture	Ash	Volatile	Carbon	Grind	Lbs Ash/ 10-6 Btu	Equivalent Moisture
RR 96	7319	1.31	26.91	13.70	27.90	31.49	-	18.72	-
RR 113	8418	.78	22.26	10.38	29.67	37.69	-	12.33	-
RR 200	7275	1.58	24.50	14.34	31.49	29.67	-	19.71	-
Averages	7671	1.22	24.56	12.81	29.69	32.95	-	16.92	-
Low	7275	0.78	22.26	10.38	27.90	29.67	-	12.33	-
High	8418	1.58	26.91	14.36	31.49	37.69	-	19.71	-
Sigma	-	-	-	-	-	-	-	-	-
Conf (95)	-	-	-	-	-	-	-	-	-

ROCKY MOUNTAIN ENERGY COMPANY - RED RIM

QUALITY REPORTS BY SEAM

DATA PROCESSING BY COMPUTING ASSOCIATES, INC

TUCSON, ARIZONA

SEAM D1

Drillhole	Btu/lb	Sulfur	Moisture	Ash	Volatile	Carbon	Grind	Lbs Ash/ 10-6 Btu	Equivalent Moisture
RR 29	8863	.62	23.82	5.57	31.27	39.34	-	6.28	-
RR 84	8432	.44	26.50	6.20	29.66	37.64	-	7.35	-
RR 96	8103	.15	26.55	7.12	28.17	38.16	-	8.79	-
RR 101	8258	.31	27.20	6.12	31.33	35.35	-	7.41	-
RR 177	8682	.30	24.55	6.70	28.97	39.78	-	7.72	-
RR 188	8220	.35	29.13	5.57	27.99	37.31	-	6.78	-
Averages	8426	.36	26.29	6.21	29.56	37.93	-	7.39	-
Low	8103	.15	23.82	5.57	27.99	35.35	-	6.28	-
High	8863	.62	29.13	7.12	31.33	39.78	-	8.79	-
Sigma	268	.14	1.74	.56	1.34	1.45	-	.78	-
Conf (95)	281	.15	1.82	.59	1.41	1.52	-	.82	-

ROCKY MOUNTAIN ENERGY COMPANY - RED RIM

QUALITY REPORTS BY SEAM

DATA PROCESSING BY COMPUTING ASSOCIATES, INC

TUCSON, ARIZONA

SEAM F1

Drillhole	Btu/lb	Sulfur	Moisture	Ash	Volatile	Carbon	Grind	Lbs Ash/ 10-6 Btu	Equivalent Moisture
*RR 15	8251	.52	20.44	13.94	29.09	36.[illegible]	-	16.89	-
*RR 125	9345	.32	16.01	11.12	30.04	42.83	-	11.90	-
*RR 128	9786	.15	15.97	6.77	32.57	44.69	-	6.92	-
*RR 132	9652	.21	15.74	7.15	33.55	43.56	-	7.41	-
*RR 135	9429	.27	16.55	8.86	32.55	42.04	-	9.40	-
Averages	9293	.30	16.94	9.57	31.56	41.93	-	10.50	-
Low	8251	.15	15.74	6.77	29.09	36.53	-	6.92	-
High	9786	.52	20.44	13.94	33.55	44.69	-	16.89	-
Sigma	-	-	-	-	-	-	-	-	-
Conf (95)	-	-	-	-	-	-	-	-	-

*Indicates area proposed for Coal Unit 4

ROCKY MOUNTAIN ENERGY COMPANY - RED RIM

QUALITY REPORTS BY SEAM

DATA PROCESSING BY COMPUTING ASSOCIATES, INC

TUCSON, ARIZONA

SEAM F2

Drillhole	Btu/lb	Sulfur	Moisture	Ash	Volatile	Carbon	Grind	Lbs Ash/ 10-6 Btu	Equivalent Moisture
RR 82	8109	.11	26.38	7.95	29.45	36.22	-	9.71	-
RR 90	7473	.19	27.81	5.26	32.30	34.63	-	7.04	-
RR 102	8065	.25	24.72	10.66	29.19	35.43	-	13.22	-
*RR 128	9970	.20	16.54	5.68	32.52	45.26	-	5.70	-
*RR 134	9607	.26	16.57	7.18	32.79	43.46	-	7.47	-
*RR 136	9327	.37	17.71	7.65	33.14	41.50	-	8.20	-
RR 176	8462	.21	24.24	8.05	29.03	38.68	-	9.51	-
RR 180	8223	.31	25.14	9.02	28.67	37.17	-	10.97	-
Averages	8664	.23	22.39	7.68	30.89	39.04	-	8.98	-
Low	7473	.11	16.54	5.26	28.67	34.63	-	5.70	-
High	9970	.37	27.81	10.66	33.14	45.26	-	13.22	-
Sigma	812	.07	4.35	1.62	1.83	3.68	-	2.24	-
Conf (95)	679	.06	3.64	1.35	1.53	3.08	-	1.87	-

*Indicates area proposed for Naal Unit 4

ROCKY MOUNTAIN ENERGY COMPANY - RED RIM

QUALITY REPORTS BY SEAM

DATA PROCESSING BY COMPUTING ASSOCIATES, INC

TUCSON, ARIZONA

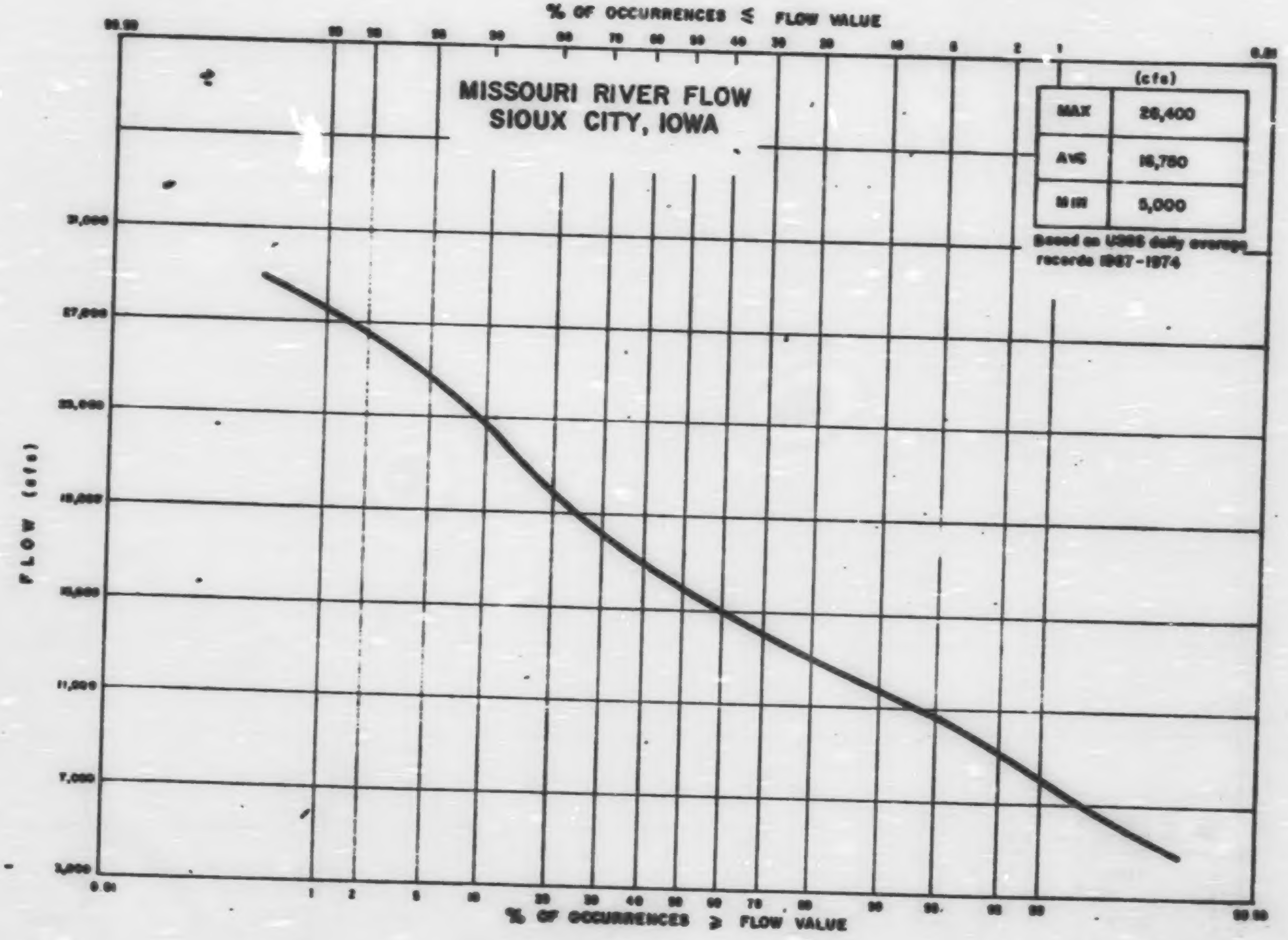
SEAM C

Drillhole	Btu/lb	Sulfur	Moisture	Ash	Volatile	Carbon	Grind	Lbs Ash/ 10-6 Btu	Equivalent Moisture
*RR 4	9465	.32	16.17	10.29	29.93	43.61	-	10.87	-
*RR 128	10046	.57	15.07	5.84	31.73	46.35	-	5.82	-
*RR 137	9706	.30	17.39	5.96	32.64	44.00	-	6.14	-
RR 190	7848	.25	27.29	6.36	27.62	38.75	-	8.08	-
Averages	9266	.36	19.23	7.11	30.48	43.18	-	7.73	-
Low	7848	.25	16.07	5.84	27.62	38.75	-	5.82	-
High	10046	.57	27.29	10.29	32.64	46.35	-	10.87	-
Sigma	-	-	-	-	-	-	-	-	-
Conf (95)	-	-	-	-	-	-	-	-	-

*Indicates area proposed for Neal Unit 4

Section A - III - B

This section contains a statistical analysis of Missouri River flow for each month of the year based on U.S.G.S. historical records. This supplements information provided in Section III-B of the Environmental Impact Statement.



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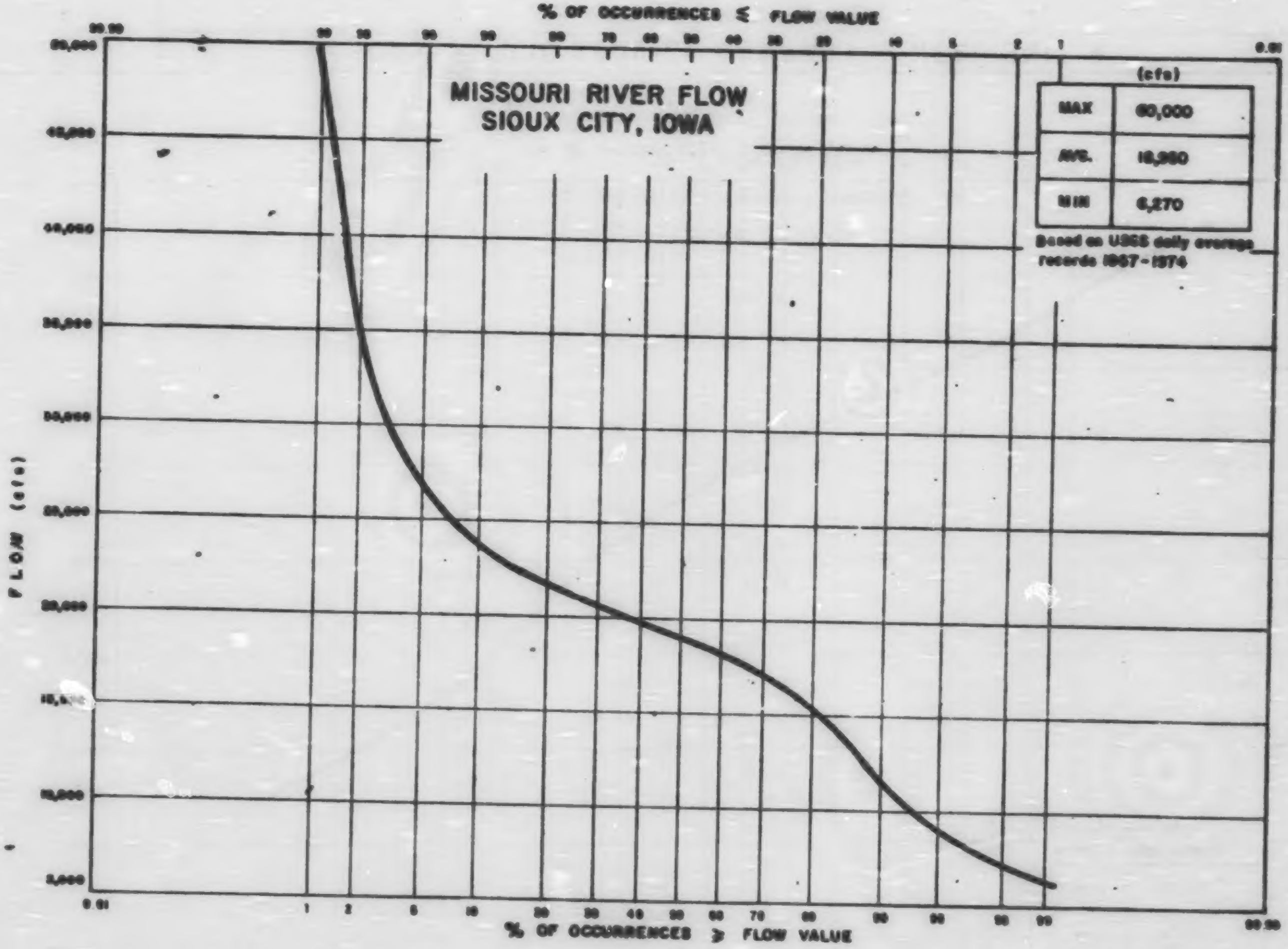
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
JANUARY

DATE:

SCALE:

EXHIBIT
A-III-B-1



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A DIVISION OF EBASCO SERVICES INCORPORATED

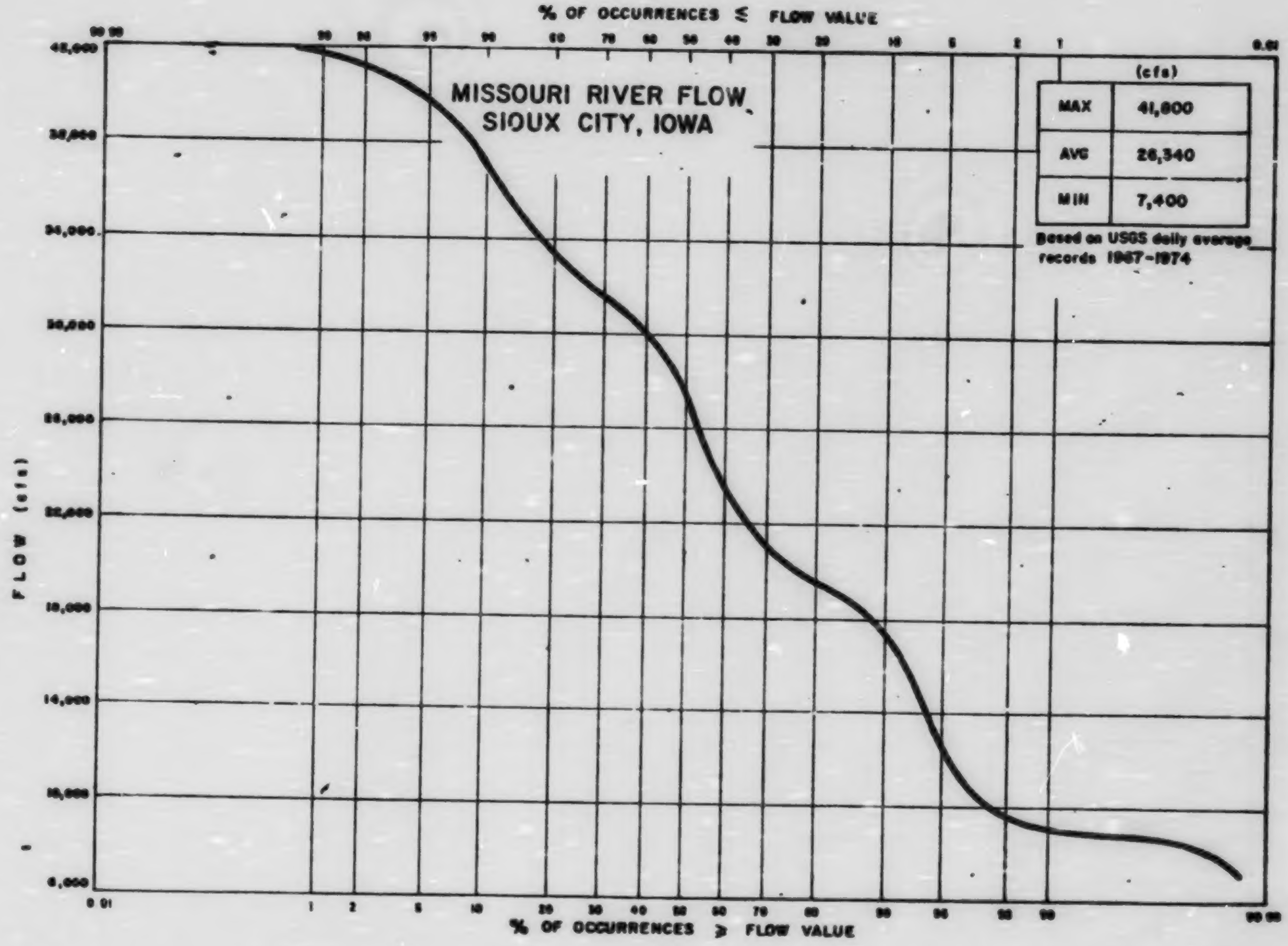
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
FEBRUARY

DATE:

SCALE:

EXHIBIT
A-III-B-2



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A DIVISION OF EBASCO SERVICES INCORPORATED

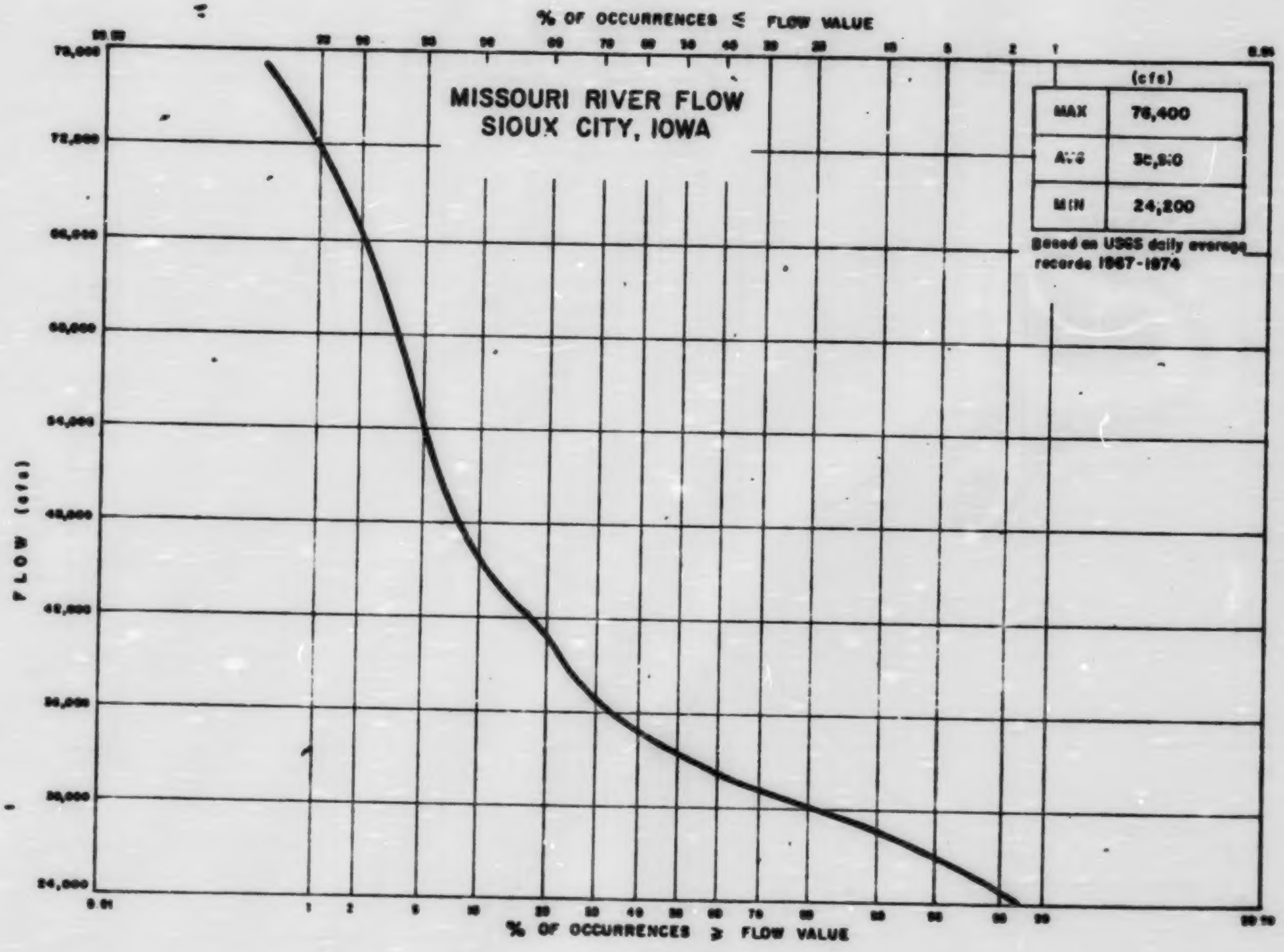
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
MARCH

DATE:

SCALE:

EXHIBIT
A-III-B-3



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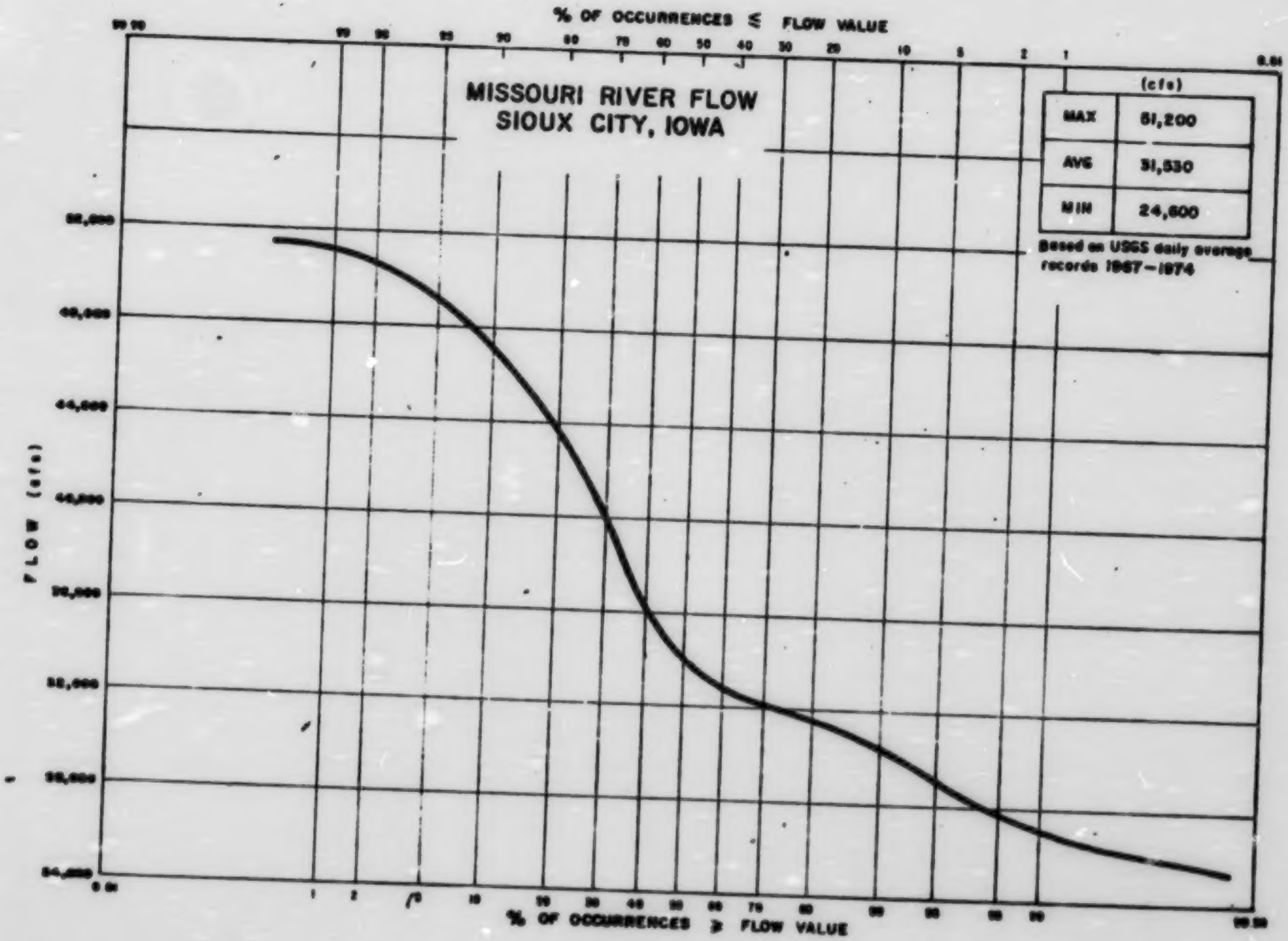
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
APRIL

DATE:

SCALE:

EXHIBIT
A-III-B-4



	(cfs)
MAX	51,200
AVG	31,530
MIN	24,600

Based on USGS daily average records 1967–1974

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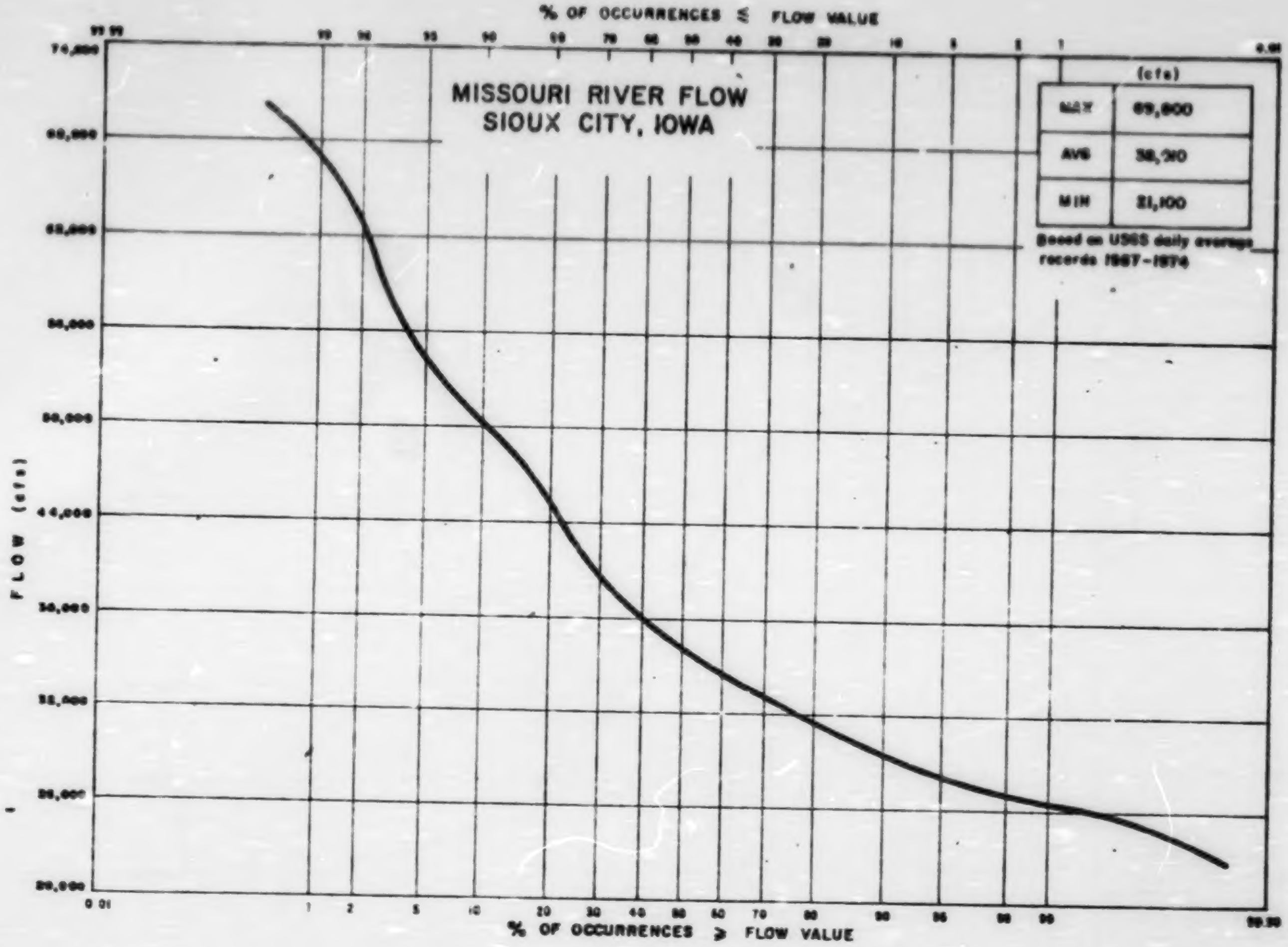
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
MAY

DATE:

SCALE:

EXHIBIT
A-III-B-5



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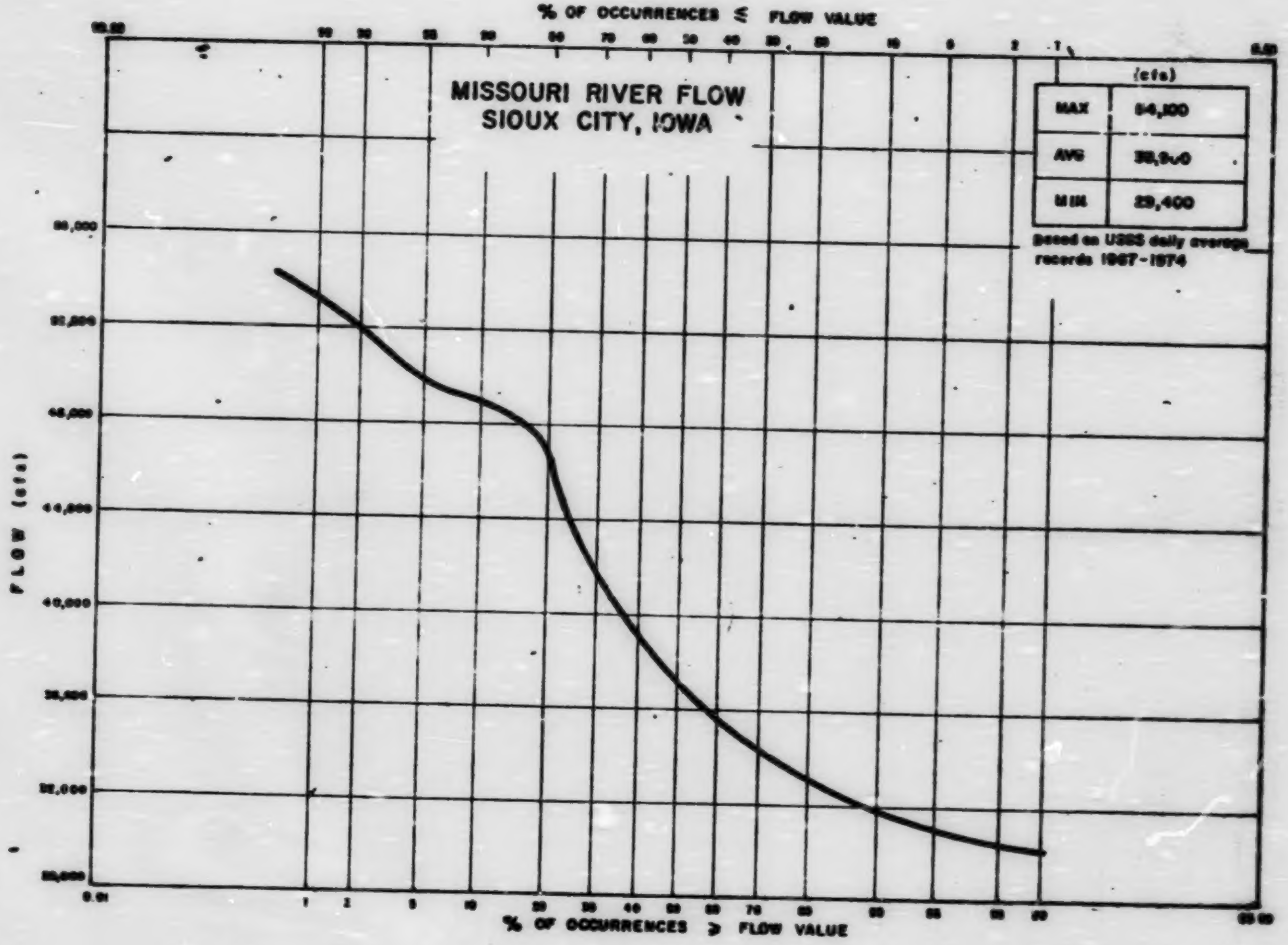
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
JUNE

DATE:

SCALE:

EXHIBIT
A-III-B-6



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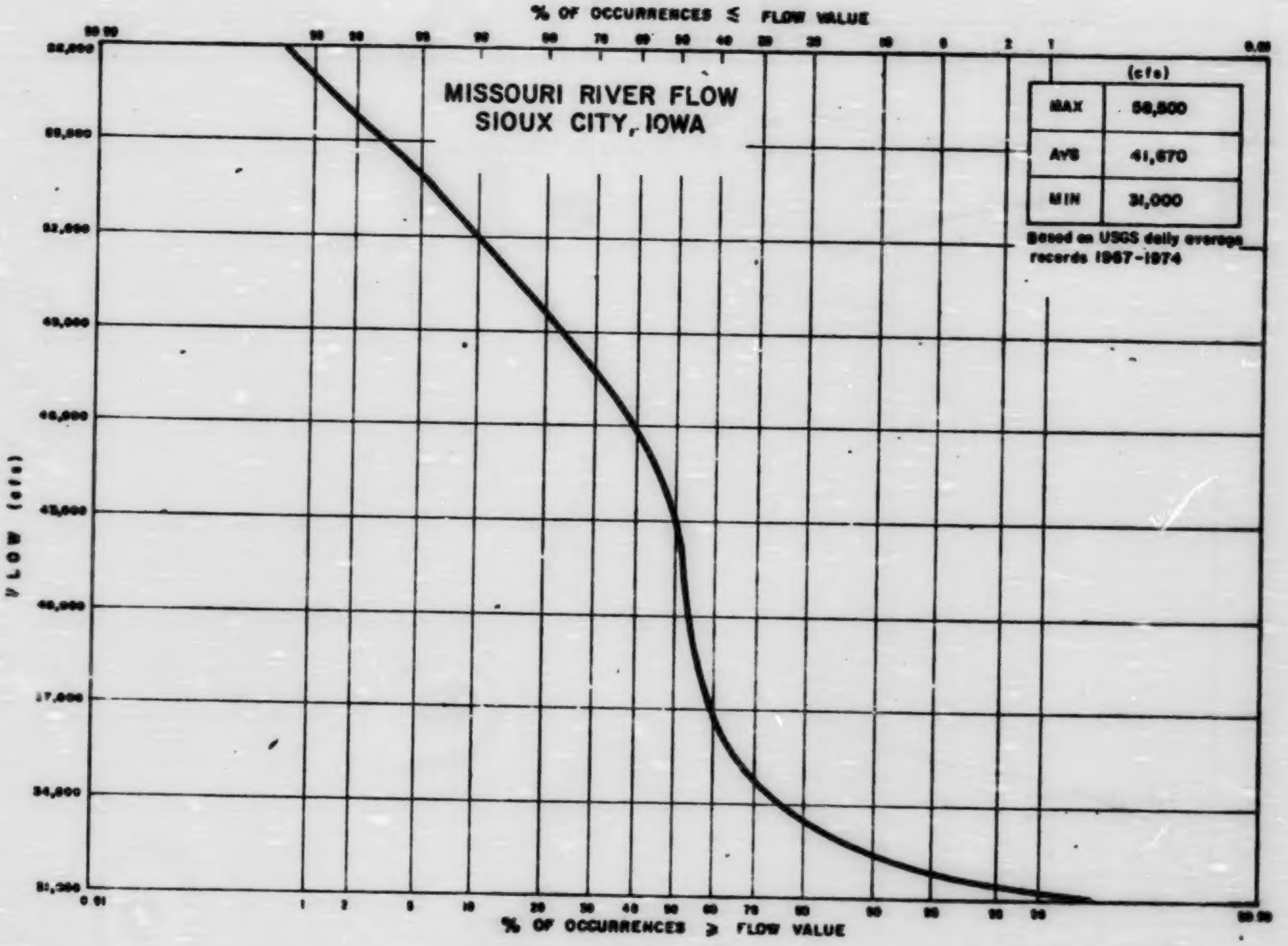
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
JULY

DATE:

SCALE:

EXHIBIT
A-III-B-7



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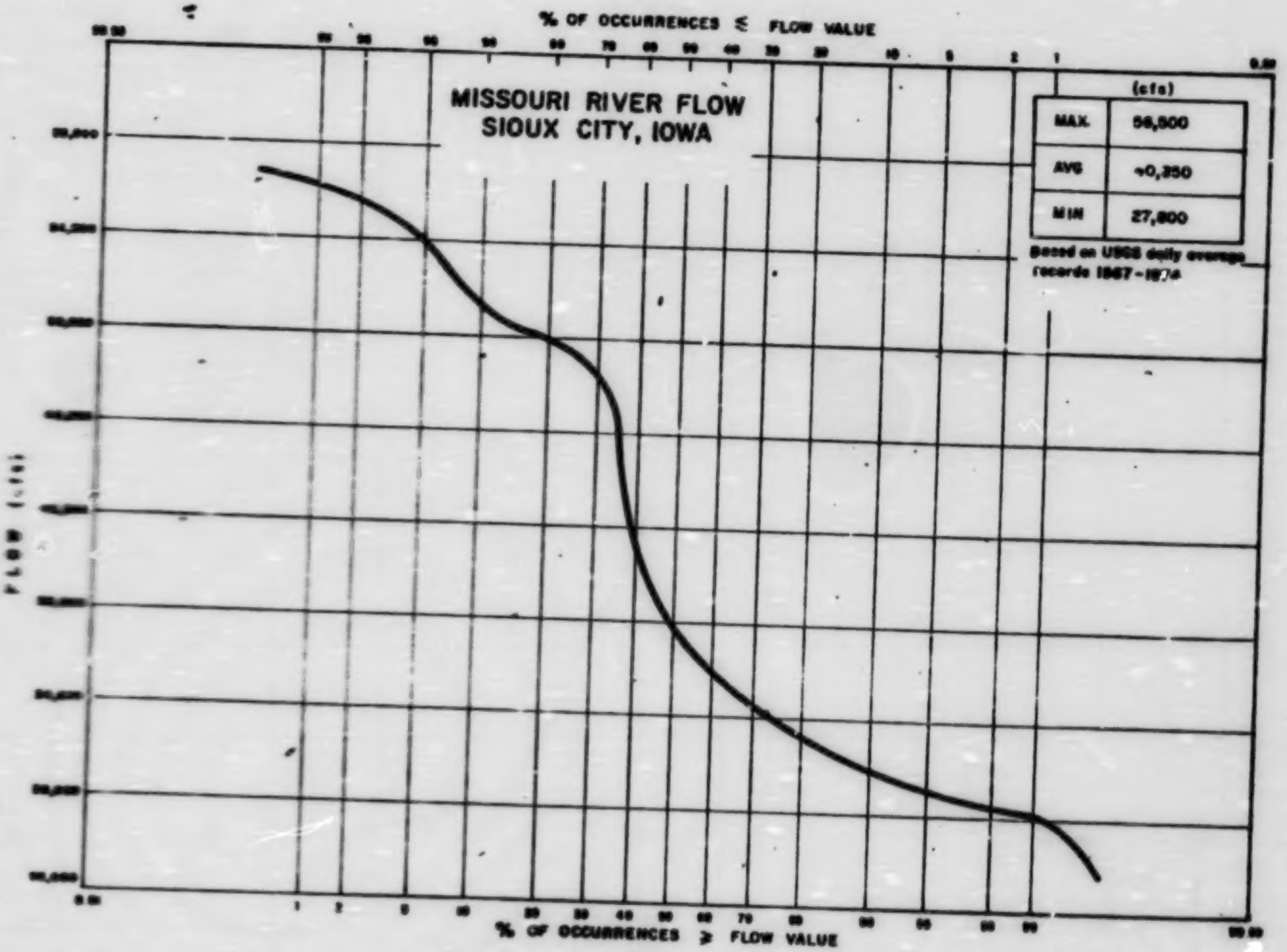
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
AUGUST

DATE:

SCALE:

EXHIBIT
A-III-E-8



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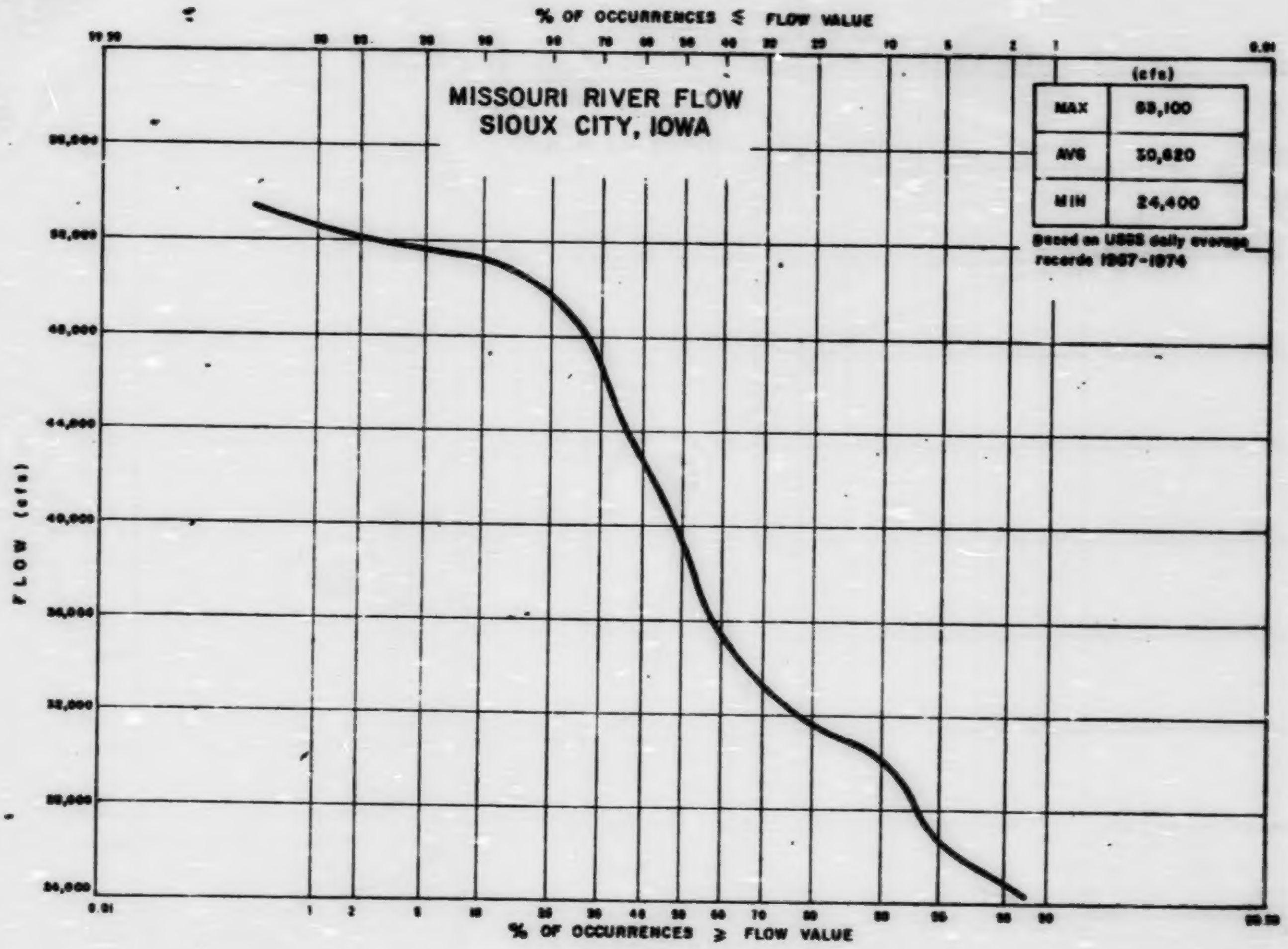
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
SEPTEMBER

DATE:

SCALE:

EXHIBIT
A-III-B-9



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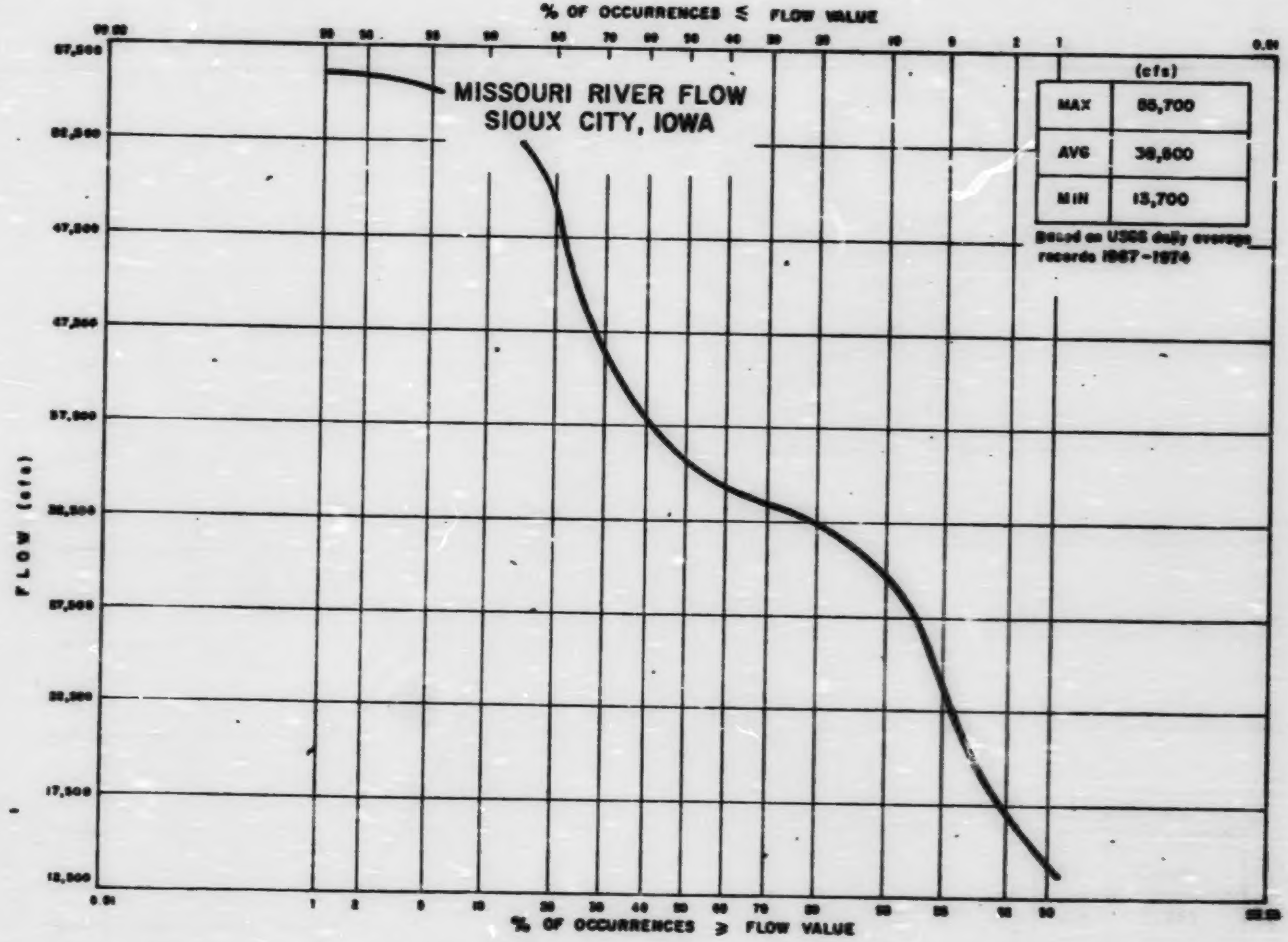
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
OCTOBER

DATE:

SCALE:

EXHIBIT
A-III-B-10



	(cfs)
MAX	55,700
AVG	30,800
MIN	13,700

Based on USGS daily average records 1967–1974

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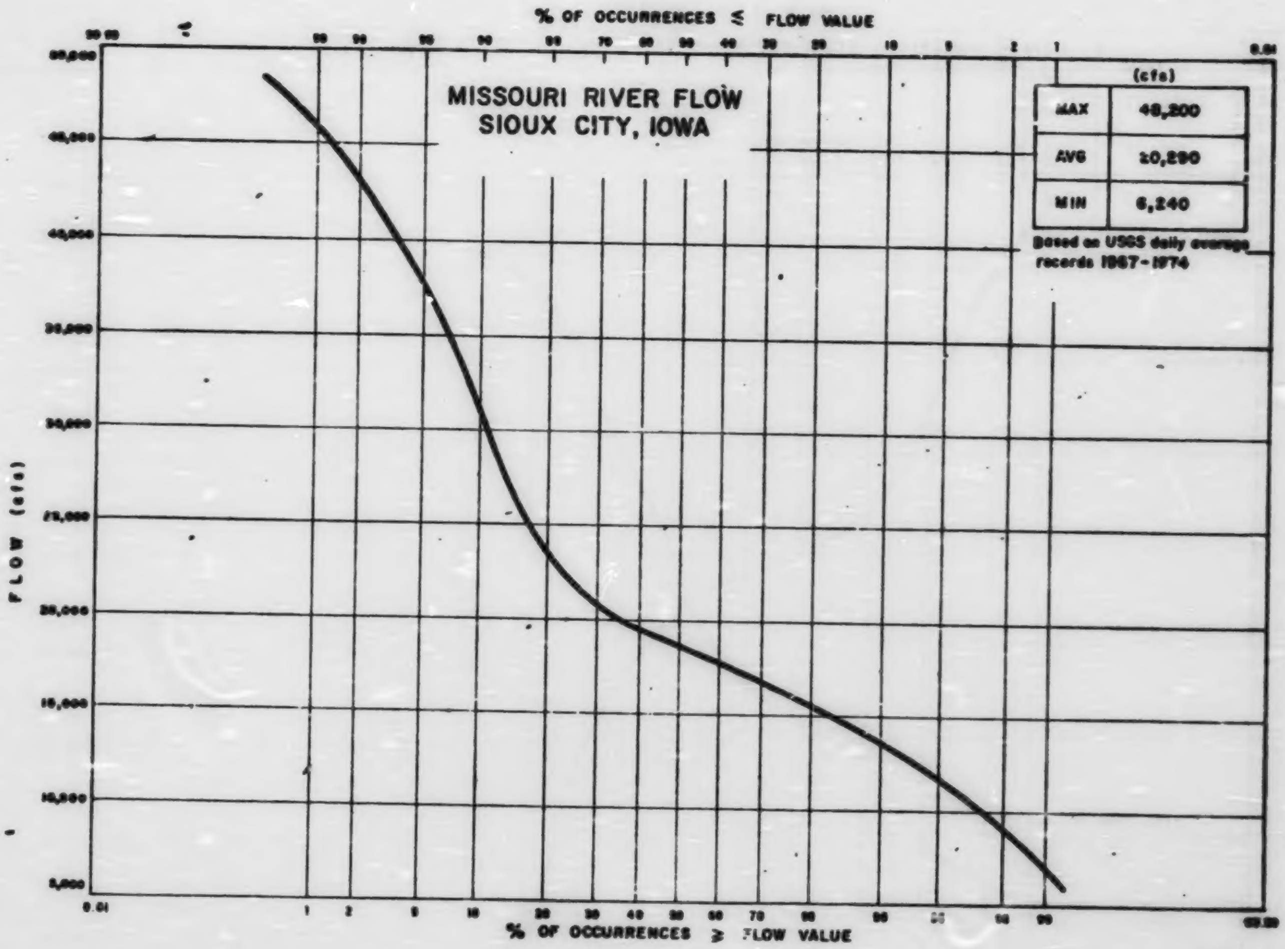
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
NOVEMBER

DATE:

SCALE:

EXHIBIT
A-III-B-11



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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

MISSOURI RIVER FLOW
SIOUX CITY, IOWA
DECEMBER

DATE:

SCALE:

EXHIBIT
A-III-B-12

Section A-III-C

This section contains a discussion of the aquatic monitoring program conducted at the George Neal Station. In addition, tables and exhibits containing data obtained during the course of the program are also presented. This supplements information provided in Section III-C of the Environmental Impact Statement.

APPENDIX A-III-C
AQUATIC MONITORING SYSTEM

A. AQUATIC MONITORING SYSTEM

The aquatic monitoring program presently being conducted [1], [2] by Briar Cliff College, Sioux City, Iowa, on the Missouri River comprises three categories: (1) Water quality monitoring; (2) biological population and community monitoring; and (3) special monitoring studies directed chiefly toward design and operation of the circulating water system. This program, which is being conducted in connection with Neal Unit 3, is developing aquatic data which can also be applied to Neal Unit 4.

A pre-operational survey at the Neal 4 station will be made during July, August and September, 1976 by gathering data to establish baseline conditions at that site and to compare these conditions at Neal Units 1-3. Instrumentation and methodology would be the same as used for previous water quality and aquatic ecology studies. Baseline studies would include a survey of physical conditions (temperature, current velocity and direction, bottom type), chemical and biological conditions of a transect just downstream from Neal 4 and a description of the area.

Following is a detailed description of the program being carried out.

1. Water Quality Monitoring

a. General Water Quality

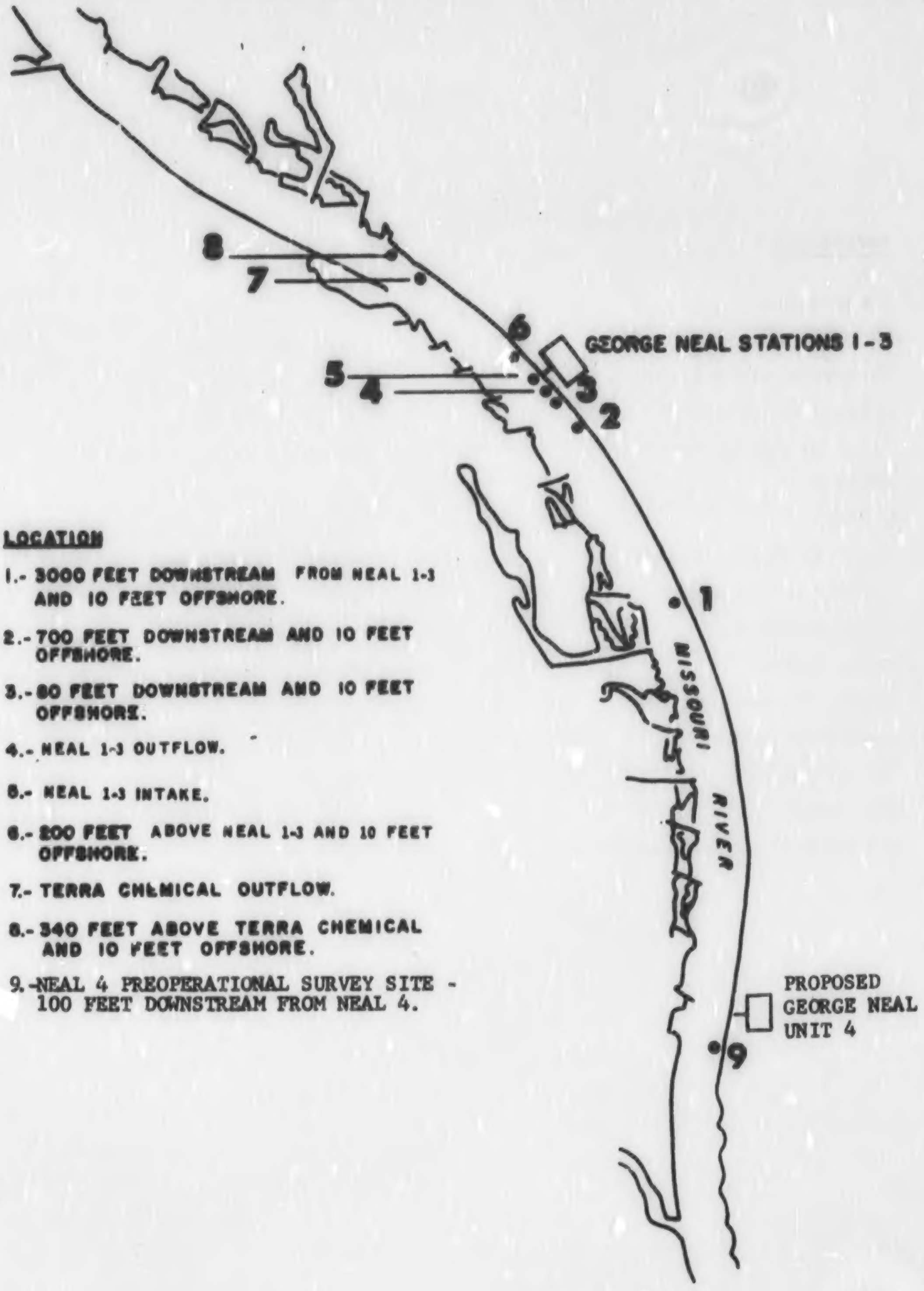
The water quality monitoring program was initiated in May, 1973 at the eight sampling stations identified in Exhibit A-III-C-a. The parameters listed in Table A-III-C-a are measured at monthly intervals. Analytical techniques are based on Standard Methods for the Examination of Water and Wastewater (APHA, 1971) employing modifications developed by the Hach © Chemical Company. Flow measurements for the Missouri River were obtained from the USGS gauging station at Sioux City, Iowa.

b. Thermal Plume Monitoring

To determine the configuration of the thermal plume from Neal Units 1, 2 and 3, additional temperature measurements are made quarterly at stations upstream and downstream of the discharge point. Temperature measurements are made with a Yellow Springs Instrument field thermister system. The plume is delineated to the point where a return to ambient temperature is observed across the stream and 1° C downstream.

2. Aquatic Ecology Monitoring

Populations of important species (Section III-C-2), as well as total community composition, are monitored throughout the Neal Station area.


8
7
6
GEORGE NEAL STATIONS I - 3
5
4
3
2
1
MISSOURI RIVER
PROPOSED GEORGE NEAL UNIT 4
9

LOCATION

1.- 3000 FEET DOWNSTREAM FROM NEAL 1-3 AND 10 FEET OFFSHORE.
2.- 700 FEET DOWNSTREAM AND 10 FEET OFFSHORE.
3.- 80 FEET DOWNSTREAM AND 10 FEET OFFSHORE.
4.- NEAL 1-3 OUTFLOW.
5.- NEAL 1-3 INTAKE.
6.- 200 FEET ABOVE NEAL 1-3 AND 10 FEET OFFSHORE.
7.- TERRA CHEMICAL OUTFLOW.
8.- 340 FEET ABOVE TERRA CHEMICAL AND 10 FEET OFFSHORE.
9.- NEAL 4 PREOPERATIONAL SURVEY SITE - 100 FEET DOWNSTREAM FROM NEAL 4.

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

WATER QUALITY AND PLANKTON SAMPLING STATIONS, MAY 1973 - PRESENT

EXHIBIT
A-III-C-a

DATE: SCALE:

Parameters	Units
Temperature	C
pH	Standard Units
Phenopthalein Alkalinity	mg/l as $CaCO_3$
Total Alkalinity	mg/l as $CaCO_3$
Total Hardness	mg/l as $CaCO_3$
Ammonia	mg/l as N
Nitrate	mg/l as N
Chemical Oxygen Demand	mg/l
Total Phosphate	mg/l
Ortho Phosphate	mg/l
Total Solids	mg/l
Total Suspended Solids	mg/l
Dissolved Solids	mg/l
Volatile Solids	mg/l
Turbidity	Foralin Turbidity Units (FTU)
Biochemical Oxygen Demand	mg/l

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SAMPLING PROGRAM
JULY 1971 - APRIL 1973

DATE:
SCALE:

TABLE
A-III-C-a

a. Algae

i. Phytoplankton

A series of eight sample sites along the Iowa shore of the Missouri River has been established (Exhibit V-C-1). Seven of these sites (site number 7 not included) have been sampled for phytoplankton on a monthly basis since May 1973. Samples collected during January and February consist of whole river water; during the other months phytoplankton is collected by pouring five gallons of river water through a Wisconsin Plankton Net (No. 20, Nitex with 173 meshes/inch; 0.076 mm aperature). Blue-green and green algae were identified in replicate samples using a micrometer disc and a Sedgwick Rafter Counting Cell. Diatoms are boiled with nitric acid, filtered through a millipore filter, which was then dried and saved for counting. Keys used for identification included Palmer[3], Patrick and Reimer[4], Prescott[5], and Weber[6].

Sampling variability experiments, incorporating spatial stratification and several stages of subsampling, were performed once in May 1974 in order to identify major sources of variation in the plankton sampling process. Thus, documentation of statistical variability which can be expected to occur within a given section of the river for a discrete time interval, was also obtained.

ii. Periphyton (attached or "aufwuchs")

Two qualitative "periphyton" surveys were conducted in the Port Neal area in 1973. In June, rocks were sampled upstream and downstream of the Neal Units 1 and 2 discharge, while in August the discharge structure was sampled in addition to the rocks.

b. Invertebrates

i. Zooplankton

From June 1973 through December 1975, zooplankton were identified and enumerated in the phytoplankton and drift samples. During the summer of 1975 (June 10, 19, 16, July 3, 17, August 14) samples were also collected at Sites 2, 5 and 6 (see Exhibit A-III-C-a by towing a metered Wisconsin Plankton Net (passing approximately 150 liters of water through the net). Samples were preserved, then counted and identified using a Sedgewick Rafter Counting Cell. Keys used in identification included Eddy and Hodson[7], Novotny[8] and Torke[9]. Because of the different collection methodologies used in the two studies, the results were not comparable.

ii. Drift

Drift net studies were initiated in March 1973. Studies are conducted bi-weekly from June to August 13, 1973 (also sampled on 9/10/73), and weekly from May 16, 1974 to August 2, 1974. Collections were made by suspending a Wildco Stream Drift Net (Nitex #6, aperture 0.24 mm) from the shore at Site 6 (about 200 feet upstream from George Neal Stations 1-3), see Exhibit A-III-C-a. The data are presented as composites of three five-minute samples for each study date.

iii. Benthic Macroinvertebrates

Hilsenhoff artificial substrate samplers were planned to be positioned on 24 sites throughout the study area during 1973 and 1974 (see Exhibit III-C- 9). Low river levels however, prevented sampling of backwater areas (samples sites 19-21) until the Spring of 1974. In 1975 only the fifteen sites (sample sites 1-15) along the Iowa side of the river were studied. The substrates were sampled monthly throughout the spring, summer and fall; some sites (sample sites 7-12) were also sampled in the winter. Samples were taken by raising the artificial substrate and rinsing it thoroughly in a tub of water. The contents were then passed through a No. 30 mesh sieve (.59 mm aperture) to collect the organisms.

c. Fish

i. Quarterly Fishery Surveys

Sampling sites (see Exhibit III-C-12) are fished quarterly with bag seines, gill and trammel nets, and electrofishing gear. A variety of habitats are incorporated in the study program; these included rock-stabilized shoreline; pockets below the ends of training dikes; backwaters between training dikes; and sandbars bordering the main channel. Units of effort are documented and length data obtained.

- Bag seining

Collections are made with a 30' by 6' bag seine with a 4' by 4' bag. Due to higher river discharges during 1975, no significant data were collected by bag seining.

- Gill and trammel nets

Two 125' experimental gill nets and up to four 140' trammel nets are used. The number of nets set depended upon river discharge rate; fewer sites being sampled at low flows, and more sites during high river flows.

- Electrofishing

In 1974 a boat-mounted 3,500 watt single phase alternating current gnerator was utilized for electrofishing. During low river flows, shocking was accomplished above and below training dikes and along the shoreline. Backwaters were shocked during the higher river discharges in 1975.

Although electroshocking was the most successful method used, it is apparently not effective on channel catfish. For a more detailed description of the electrofishing technique see Section A-III-C-3-c.

ii. Winter Kill Survey

Surveys of backwaters were conducted in late winter, after most of the ice had melted and before the dead fish had been removed by scavengers. The numbers and species of stranded fish were noted during the surveys.

iii. Larval Fishes

Fish larvae were collected with Wildco Stream Drift Nets (Nitex #6, aperture of 243 microns) in the intake chamber of Neal 1 and 2 and just off-shore at site 6 during June and July of 1973, May, June, July and August of 1974, and April, May, June, July and August of 1975.

During 1974, 30-minute collections at the intake structure and 5 minute collections at site 6 were performed weekly. Data from the intake structure samples are presented as a composite of 4 thirty-minute samples for each date. Data for site 6 represent a composite of three five-minute drift net samples.

In 1975 collections were made once a week in May and August and twice a week in June and July. The only procedural difference was the use of a Gurley-Teledyne Velocity Meter to measure water velocities allowing computation of the time required to sample 4,300 gallons of water.

3. Special Studies

a. Entrainment

Condenser intake studies were conducted during the summers of 1973 and 1974 for the purpose of identifying and enumerating invertebrates and larval fish (and eggs in 1974) entering the Neal Station intake structures. In 1973, 24 hour intake studies were conducted with a Nitex Net with an aperature of 1.050 mm. Beginning in 1974, condenser intake studies of 30 minutes each were conducted with a Wildco Stream Drift Net (Nitex .243 mm). The 1974 data is presented as composites of four 30 minute samples per date.

b. Impingement

A year long impingement study initiated in February 1974, was undertaken to determine types, numbers and condition of fish impinged on the Units 1 and 2 traveling screens. Samples were collected using a trash basket (wood frame with a hardware screen, 3/8" mesh) inserted into a screen wash sluiceway between the third and fourth intake bays. The box was left in the trough until the accumulation of debris impeded the flow of water. Collections were made during staggered four hour shifts. Data were collected for 16 hours per week from February - May 1974 and for 24 hours per week from June 1974 - February 1975. Beginning January 11, 1976, for one year, a similar impingement study was initiated at the Neal Unit 3 intake.

c. Thermal Attraction

Electroshocking was conducted every two weeks during May to October 1974 above and below the Neal Station in order to determine attraction of fish to the thermal discharge. The length of shoreline in each shocking run was extended from 1,200 feet in 1973 to 2,300 feet in 1974. In 1974, the presence of an ammonia discharge near site 7 led to the addition of a third 2,300 foot length of shoreline on June 28, as a control.

In 1973, the thermal attraction study was conducted on four sampling dates. Fishing was usually conducted after 3 PM with a three phase 230 volt A.C. generator with boom type shockers. In the May to October 1974 study, shocking times were spread throughout the day using a single phase 230 volt A.C. generator with the same type of shockers as used in the 1973 study.

All fish collected were identified, examined for tagging marks, measured and weighed. Fish collected downstream from the Neal Station on July 13, 1973 were marked by clipping the lower caudal fin; those captured in 1974 were marked by clipping the left pelvic fin.

A-III-C - AQUATIC MONITORING SYSTEM

A-III-C-1 Hey, J and Baldwin, K 1975. Aquatic Ecology Study (Pre-Operational Survey, Unit III) of the Missouri River near the George Neal Station, Sioux City, Iowa, June 1974 - December 1975.

A-III-C-2 Hey, J and Baldwin, K 1976. Impingement Studies, Neal III. Also Relative Abundance Estimates - Neal II, Preliminary Recommendations for Design and Operation of Intake and Screens.

A-III-C-3 Palmer MG. 1962. Algae in Water Supplies. US. Dept. New Public Health Service Pub. No. 657 - US. GPO, Wash. DC.

A-III-C-4 Patrick R and CW Reimer. 1966. The Diatoms of the United States Vol-1. Monogr. ANSP No. 13

A-III-C-5 Prescott GW. 1964. How to know the Fresh-water Algae. Wm C. Brown Co. Dubuque, Iowa

A-III-C-6 Weber, CI. 1971. A Guide to the Common Diatoms at Water Pollution Surveillance System Stations. US Environmental Protection Agency, Cincinnati, Ohio

A-III-C-7 Eddy S and AC Hodson. 1961. Taxomonic keys to the Common Animal of the North Central States. Burgess Pub. Co. Minneapolis, Minn.

A-III-C-8 Novotny, JF. 1975. A Guide to the Identification of Common Crustacean Zooplankton in Missouri River Reservoirs. Unpublished.

A-III-C-9 Torke, Byron G. 1974. Special Report No. 17: An Illustrated Guide to the Identification of the Planktonic Crustacea of Lake Michigan with Notes on Their Ecology. Center for Great Lakes Studies, The University of Wisconsin - Milwaukee.

TABLE A-III-C-1

ABUNDANCE AND DISTRIBUTION OF PHYTOPLANKTON GENERA - VICINITY OF NEAL UNITS 1-4 MAY 1973 - DECEMBER 1975

Reproduced from best available copy.

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

PLANKTON - MAY 14, 1973
(counts 1 river water)

Genera	Sampling Sites 1	2	3	4	5	6	7	8
BLUE GREEN ALGAE								
Aphanocapsa								
Oscillatoria								
GREEN ALGAE								
Ankistrodesmus								
Chlorella								
Closterium								
Coelastrum								56
Oocystis								
Pandorina								
Pediastrum	56		84	84				56
Scenedesmus	20	56	84	56			56	
Spirogyra						20		
Ulothrix	56		84					
Volvox		20						
DIATOMS								
Asterionella	236,441	287,951	265,420	325,018	505,222	262,781	124,331	299,162
Caloneis					101			
Cocconeis						101		101
Cyclotella	2,929	3,333	3,232	3,434	758	3,232	505	5,050
Cymatopleura	101							
Cymbella		202	101	606	101		101	
Diatoma	202	905	404	12,625	202	404	202	303
Fragilaria	1,848	2,121	9,090	8,"0"	5,555	10,281	3,131	4,394
Gomphonema	101	202	606	3,030	905	606	303	303
Gyrosigma								
Hantzschia								
Melosira	1,111	"0"	905	1,010	1,111	1,212		606
Navicula	101	202		4,343	1,818	303	202	303
Nitzschia	1,212	1,414	1,111	79,487	4,242	1,919	303	808
Stauroneis								
Stephanodiscus	8,101	15,455	9,191	10,403	8,505	6,363	404	15,554
Surirella	1,111	404	506	104		"0"		303
Synedra	1,010	808	1,616	1,919	1,414	10,100	202	1,262
Pleurosigma								
Tabellaria								
Pinnularia				101		101		
Total Count	25[illegible]	311,366	292,142	451,907	329,642	29[illegible]	129,740	328,261

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 1 OF 31)

DATE:

SCALE:

TABLE A-III-C-1

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

PLANKTON - JUNE 11, 1973

(counts/l river water)

Genera	Sampling Sites 1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Oscillatoria	84	28		590	197	84	84
GREEN ALGAE							
Chlorella	79	112			28	28	28
Closterium							84
Coelastrum			28			28	56
Oocystis			56				
Pediastrum	112	140	56			197	56
Scenedesmus	112	56				28	
Spirogyra		28	28				
Ulothrix	562	56	112		84	140	84
Actinastrum	674	534	140	337	337	1,096	252
Micractinium			28				56
DIATOMS							
Asterionella	103,323	141,400	114,130	19,695	100,747	113,221	103,020
Caloneis		101					
Cocconeis					50		
Cyclotella	1,444	4,141	2,575	3,080	3,888	2,727	3,434
Cymatopleura		50					
Cymbella	101				50	101	101
Diatoma	202	101	50		50	101	101
Fragilaria	7,171	8,484	3,030	2,929	5,050	2,727	5,353
Gomphonema	202	202	252	151	202		202
Gyrosigma							202
Melosira	505	1,515	101	202	404	808	404
Navicula	909	404	1,161	67,215	3,888	1,212	404
Nitzschia	2,222	1,414	707	64,690	3,737	909	505
Stephanodiscus	7,575	6,565	6,817	3,080	3,535	5,656	5,959
Surirella	202		50	101		202	
Synedra	505	505	404	101	50	101	606
Total Count	121,933	165,786	129,775	162,171	122,230	129,338	120,735
(organisms ml concentrated sample)							
ROTIFERS	5	4	2	4	8	10	1
CRUSTACEANS							
Cyclops	14	9	9	3	13	10	5
Diaptomus	6	1	7	1	4	6	3
Daphnia	7	6	13	2	12	7	2
OTHER							
Hydra		1	2			1	
Larval Water Mite	6			1		4	
Vorticella							

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -

DECEMBER 10, 1975 (SHEET 2 OF 31)

DATE:

SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON - JULY 10, 1973
(counts/l river water)

Genera	Sampling Sites 1	2	3	4	5	6	8
BLUE GREEN ALGAE							
Lyngbya				42			
GREEN ALGAE							
Coelastrum							42
Pediastrum	84			42		42	42
Scenedesmus	42	42	42				
Ulothrix			42				
DIATOMS							
Asterionella	101	505	202	101	303	202	101
Cocconeis						101	
Cyclotella	5.151	7.676	5.454	9.090	9.090	10,900	4.343
Cymatopleura			101				
Cymbella				202			
Diatoma	101	505	202	101	303	505	
Fragilaria	1.111	404	101	606	606	909	1.313
Gomphonema	101	101	404		202	505	303
Melosira	707	606	303	404	2.323	505	101
Navicula	606	1.919	909	2,020	1.212	808	505
Nitzschia	2.121	5.131	2.424	4,040	3.131	3,232	2.626
Stephanodiscus	1.515	1.616	404	1.212	808	1.616	808
Surirella	101	606	404		707	303	
Synedra		101	101	202	505	808	101
Pleurosigma		101				202	
Pinnularia				101			
Total Count	11.741	17.413	11.094	18.163	19.990	20.646	10.285
(organisms ml concentrated sample)							
ROTIFERS							
CRUSTACEANS							
Cyclops	30	10	13	19	30	24	13
Diaptomus	11	5	10	6	[illegible]	12	2
Daphnia	8	4	8	1	4	12	2
OTHER							
Euglena	1						
Nematoda							
Larval water mites	2					1	

Source Baldwin and Hey 13/, Hey and Baldwin 14,15/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 3 OF 31)

DATE:

SCALE:

TABLE
A-III-C-1
(Cont'd)

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

PLANKTON – AUGUST 6, 1973
(counts/l river water)

Genera	Sampling Sites 1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Anacystis	169	84	84	169	84	127	211
Oscillatoria				295			42
Stichococcus	380	84	127			42	127
Lyngbya				295		42	
GREEN ALGAE							
Ankistrodesmus	211	211		42	42		
Chlorella	84	42			84		42
Coelastrum	295	84		84	42		
Pediastrum	42	42	127	42	84		42
Scenedesmus	295	380	211	211	675	422	295
Ulothrix	127		84		169		42
Actinastrum	127	295	295	84	169	127	169
Staurastrum		127		84	42		
Stigeoclonium				295			
Roya							42
Micractinium							42
BROWN ALGAE							
Ceratium	42						
DIATOMS							
Asterionella	158	158				79	
Cyclotella	12,757	15,829	8,426	9,056	8,899	12,600	12,206
Cymbella			158	315	158	79	
Diatoma		158			79	158	158
Fragilaria		158	158	709	79	551	315
Gomphonema				393			79
Melosira	1,102	551	158	1,418	158	315	630
Navicula	709	787	1,181	11,734	1,103	1,181	630
Nitzschia	1,260	1,654	2,678	58,669	2,678	2,678	1,103
Stephanodiscus	1,102	2,126	709	1,181	945	236	1,024
Surirella			158			945	
Synedra	79	315		473	79	79	236
Rhoicosphenia			79				
Total Count	18,939	23,084	14,633	85,549	15,611	19,661	17,435
	(organisms/ml concentrated sample)						
CRUSTACEANS							
Cyclops	5	9	11	3	3	4	2
Diaptomus	5	1	4	4		3	3
Daphnia	15	11	8	9	8	11	7
OTHER							
Larval water mite	1	1	5				

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 4 OF 31)

DATE:

SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON – SEPTEMBER 10, 1973
(counts/l river water)

Genera	Sampling Sites						
	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Oscillatoria		65			NC*		
Stichiosiphon				390		260	
GREEN ALGAE					NC*		
Chlorella	260						
Closterium		65					
Coelastrum	65	65					
Pediastrum	195		130	195		65	65
Scenedesmus	780	260	585	690		195	715
Ulothrix	780	520	130	195		390	690
Actinastrum	65		65	65		195	
Spirogyra				65			
Diatoms							
Asterionella	79	79	79	158	316	237	
Cyclotella	8,532	7,979	5,846	9,164	6,320	6,241	7,505
Cymbella	158	237	79		158	158	
Diatoma	79						
Fragilaria	79	316	79	316		158	158
Gomphonema				79			
Melosira	1,422	1,730	1,027	237	1,896	948	1,422
Navicula	1,901	711	790	1,422	316	790	474
Nitzschia	1,943	1,943	790	1,422	948	1,264	1,580
Stephanodiscus	1,730	2,133	1,757	1,730	1,106	2,528	1,730
Surirella		158	79		158		
Synedra	237			158			158
Total Count	17,413	15,604	11,417	26,254		13,429	14,465
(organisms/ml concentrated sample)							
CRUSTACEANS							
Cyclops	1	1	1				3
Diaptomus		1					
Daphnia			1				

* NC – The Blue-Green and the Green Algae were not counted

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

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IOWA PUBLIC SERVICE COMPANY – NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 –
DECEMBER 10, 1975 (SHEET 5 OF 31)

DATE:
SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON - OCTOBER 11, 1973
(counts/l river water)

Genera	Sampling Sites						
	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Oscillatoria	65			2.080	65	130	65
GREEN ALGAE							
Chlorella	130		65		65	65	
Pandorina						65	
Pediastrum	195	65	130		130		
Scenedesmus	520	520	195	65	65	65	195
Ulothrix		65	195		130	130	195
Actinastrum	65						
Pleurococcus	65						
DIATOMS							
Asterionella	79		79	79	158	79	79
Cyclotella	5.451	5.925	7.189	10.586	8.769	5.372	5.688
Cymbella	158		79		79	79	158
Diatoma			79				158
Fragilaria	79	158	237	79			
Gomphonema				158	316		
Melosira	237	316	79	237	79		158
Navicula	1.569	1.105	1.343	3.002	1.659	1.422	632
Nitzschia	1.105	632	1.422	5.056	1.817	1.580	869
Stauroneis			79	79			
Stephanodiscus	3.555	2.212	711	553	553	869	632
Surirella	79			158			
Synedra	237		79			79	158
Rhoicosphenia							79
Total Count	13.604	11.078	11.961	22.132	13.885	9.856	9.066

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

envirosphere company

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1976 (SHEET 6 OF 31)

DATE:

SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON - DECEMBER 4, 1973
(counts/l river water)

Genera	Sampling Sites						
	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Stichococcus		65		65	195	130	
GREEN ALGAE							
Coelastrum							
Pandorina			65		65		
DIATOMS							
Asterionella		79			79		
Cocconeis						79	
Cyclotella	6,636	7,742	7,821	9,400	10,981	5,767	7,821
Cymbella			237	79			
Diatoma		79	237		237		79
Fragilaria	237	79	553	237	158		
Gomphonema		158		553		79	79
Gyrosigma	79				79		
Navicula	1,106	632		553	316	158	237
Nitzschia	869	474	553	237	158	237	632
Stephanodiscus	237					79	79
Surirella	79	79		158	79	79	237
Synedra		79					
Total Count	9,243	9,387	9,466	11,462	12,347	6,608	9,164

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 7 OF 31)

DATE:

SCALE:

TABLE A-III-C-1 (Cont'd)

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PLANKTON - JANUARY 8, 1974
(counts/1 river water)

Genera	Sampling Sites 1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
GREEN ALGAE							
DIATOMS							
Cyclotella	517,154	559,894	448,770	341,920	512,880	414,578	594,086
Cymbella		4,274				4,274	
Diatoma	4,274		8,548				
Navicula	38,466	17,096		4,274	76,932	12,822	17,096
Nitzschia	21,370	8,548	17,096	8,548	102,576	8,548	
Stephanodiscus	29,918	12,822	38,466	21,370	12,822	17,096	21,370
Surirella		12,822	12,822	4,274			
Synedra					8,548		
Total Count:	611,182	615,456	525,702	380,386	713,758	457,318	632,552

PLANKTON - FEBRUARY 7, 1974
(counts/1 river water)

	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
GREEN ALGAE							
DIATOMS							
Asterionella	1,453,160	1,709,600	1,200,994	**	1,213,816	1,521,544	1,995,736
Cyclotella	1,414,694	1,119,697	739,602		538,524	517,154	855,102
Cymbella	4,274						
Diatoma		8,548	4,274		4,274		8,548
Fragilaria	4,274				34,192		
Gomphonema		8,548					
Navicula	42,740	99,879			8,548	8,548	12,822
Nitzschia	12,822	85,470	25,644		8,548	4,274	17,096
Stephanodiscus	12,822	42,755			8,548	12,822	8,548
Surirella	8,548	17,094	4,274		8,548	17,096	8,548
Synedra		8,548	4,274			4,274	
Total Counts	2,953,334	3,099,826	1,970,862		1,824,998	2,085,712	2,564,400

** Note No 4 was not sampled on February 7, 1974

Source: Baldwin and Hey 13/, Hey and
Baldwin 14,15/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 8 OF 31)

DATE:

SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON - MARCH 6 1974
(counts/l river water)

Genera	Sampling Sites						
	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
GREEN ALGAE							
Scenedesmus							158
DIATOMS							
Asterionella	34,808	35,280	44,100	31,106	73,552	24,570	30,712
Cyclotella	8,505	7,796	6,694	9,765	10,395	10,474	8,899
Cymbella	79			79			
Diatoma	472	315	315	79	551	79	158
Fragilaria		79	866	394	79		315
Gomphonema	79				158		315
Melosira						79	
Navicula	79	236	630	709	236	315	236
Nitzschia	551	709	315	1,410	788	315	944
Stephanodiscus	236		79				
Surirella	158		79	236	315	79	236
Synedra	158	79		79	79	158	551
Total Count	45,125	44,494	53,078	45,865	86,153	36,069	42,496
	(organisms/ml concentrated samples)						
CRUSTACEANS							
Cyclops	15	2		4	5	2	10

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

environsphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
PLANKTON DATA, MAY 14, 1973 – DECEMBER 10, 1975 (SHEET 9 OF 31)
DATE:
SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON - APRIL 4, 1974
(counts/l river water)

Genera	Sampling Sites						
	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Oscillatoria				125			
GREEN ALGAE							
Chlorella	62	62					
Ulothrix					187		
DIATOMS							
Asterionella	48,589	87,176	150,649	143,482	153,956	117,889	63,236
Cyclotella	19,451	16,144	20,002	19,550	35,399	25,672	23,704
Cymbella				79			
Diatoma		315	315	236	315	551	315
Fragilaria	551	1,339	1,260	709	1,339	630	789
Gomphonema		158	79	79	79	79	
Melosira			79	315		79	
Navicula	158	709	315	1,496	788	158	315
Nitzschia	551	551	551	2,914	1,024	236	630
Stauroneis						158	
Stephanodiscus	236	79	158	315	1,890	236	
Surirella	79	79	158	236	236	79	79
Synedra	79	158	158	236		79	
Total Count	69,755	136,770	173,724	169,752	195,173	145,846	[illegible]

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 10 OF 31)

DATE:

SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON - MAY 1, 1974
(counts/l river water)

Genera	Sampling Sites						
	1	2	3	4	5	6	8
BLUE-GREEN ALGAE							
Oscillatoria				1,304	130		
Unknown			65				
GREEN ALGAE							
Pediastrum	65		158				158
Scenedesmus	158	158					
Phacus	65						
DIATOMS							
Asterionella	230,344	249,630	247,432	213,255	234,124	240,096	240,180
Cyclotella	14,096	14,490	10,001	12,049	7,954	11,090	8,984
Cymbella			79	472	79		
Diatoma	551	788	315	551	315	551	236
Fragilaria	4,174	945	2,126	1,654	2,126	2,040	3,465
Gomphonema	394	315			79		79
Gyrosigma	79	79			79		
Melosira			79	158			
Navicula	1,102	1,181	630	1,575	472	788	472
Nitzschia	158	394	158	5,512	2,992	236	630
Stauroneis				79			
Stephanodiscus	709	551	551	315	551	866	551
Surirella		551		394	158	236	
Synedra	630	472	394	236	551	630	315
Pleurosigma							158
Total Count:	252,497	269,534	261,960	237,554	249,610	257,749	254,080
ROTIFERS	(organisms/ml concentrated sample)						
CRUSTACEANS							
Cyclops	8	31					
OTHER							
Amoeba		1					

Source: Baldwin and Hey 13/, Hey and Baldwin 14,15/

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -

DECEMBER 10, 1975 (SHEET 11 OF 31)

DATE:

SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON

(counts/liter river water)

June 4, 1974

Sampling Sites:

	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae							
Anacystis	130	130		65			
Oscillatoria	130			326	913	65	65
Spirulina					65	1891	1434
Green Algae							
Actinastrum	3260	2217	1239	456	848	2021	1891
Ankistrodesmus	196	65				130	
Chlorella		65			65		65
Closterium		65		65	65	65	
Coelastrum	326						
Endorina		130					
Micractinium		65					65
Pandorina	65	65	65				
Pediastrum	261	65	65	130	65		65
Quadrigula	65						
Scenedesmus	1304	848	261	65	130	522	326
Treubaria						65	
Ulothrix	261	196	261	130	261	65	130
Diatoms							
Asterionella	431550	534870	391388	175612	266962	235936	223020
Cyclotella	26932	17168	11498	5198	10710	7718	7876
Cymbella			158				
Diatoma	472	316	316	1732	158		
Fragilaria	5040	6930	4724	6772	6616	3938	3464
Gomphonema	158	472		1418			
Melosira	1260	1418	316	472		788	316
Navicula	944	1260	630	229792	13230	1418	788
Nitzschia	2204	1890	944	321458	23940	1102	1102
Stauroneis	630	472					
Stephanodiscus	2836	1260	630	630	944	472	788
Suriella	472	158					
Synedra	630	2362	788	158	630	1102	158
Pleurosigma						316	
Total	479126	572487	413283	744479	325602	257614	241553

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 12 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
(counts/liter river water)
July 2, 1974

Sampling Sites:	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae							
Anabaena	65	65					65
Anacystis	326	130	391	65	196	65	196
Oscillatoria				1826	130		
Stichosiphon	65					65	65
Unknown	196	326	130	130	261	196	326
Green Algae							
Actinastrum	65	65	130	261		65	
Chlorella	326	130	261	65	130		130
Closterium		65	65				
Coelastrum	326	196	196	261	196	65	196
Pediastrum	65			65	130	65	65
Rhizoclonium						65	
Scenedesmus	522	913	782	326	1108	913	1239
Stanrastrum	65	65	130				
Stigeoclonium				65			
Unknown		130	196	196	196	65	391
Diatoms							
Asterionella	74656	78592	57802	46306	62686	64732	27406
Cyclotella	24412	23626	14806	1496	21106	15436	24412
Cymbella	158						
Diatoma		158					
Fragilaria	946	1260	946	1418	1576	946	1260
Gomphonema			316				
Melosira	2206	6772	1890	1260	5198	946	1418
Navicula	1260	2678	472	11026	3150		788
Nitzschia	3150	2992	1260	54652	3622	1418	1732
Stauroneis					158		
Stephonodiscus	630	2048	316	316	630	472	472
Suriella						158	
Synedra	158	472	316	316	630	158	316
Unknown				316			
Total	109597	120683	80405	120366	101103	85830	60477
Other		(counts/ml concentrated sample)					
Actinophrys					1		
Ceratium	1	1		1			
Difflugia		1				1	2
Dinobyron					2	1	
Unknown violet filament				1			
Vorticella	3						

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 13 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
(counts/liter river water)
August 1, 1974

Sampling Sites:

	Neal IV	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae								
Anacystis			130		196	65		65
Oscillatoria					130			
Stichosiphon			65		65	196		
Green Algae								
Actinastrum			130	196	65	65	261	
Chlorella		130	130	65				
Coelastrum				65		456	65	65
Oocystis		65	65			65		
Pediastrum		65	65	65			65	
Scenedesmus	65	130	978	652	326	978	978	1304
Selenastrum			65		65		130	
Spirogyra				65				
Stigeoclonium					65	65		
Unidentified			130	65	65	65	130	130
Diatoms								
Asterionella	19372	4568	6614	4252	1102	1260	2048	
Cyclotella	1102	3150	15278	14648	9922	16380	18742	17640
Fragilaria			158			472		158
Melosira	158	158	316			158		158
Navicula	158	630	1102	316	1260	788	1102	158
Nitzschia	158	630	1102	630	6458	2992	1890	1574
Stauroneis							158	
Stephanodiscus			316	158	788		158	472
Suriella			158	158				
Synedra			316	472	158	158		
Total	21013	9526	27118	21807	20665	24163	25727	21659
Other		(counts/ml concentrated sample)						
Chlamydomonas						1		
Euglena					1			
Volvox							1	
Vorticella		1						

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 14 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
(counts/liter river water)

September 9, 1974

Sampling Sites:

	Neal IV	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae								
Anabaena					65			
Anacystis						65		
Calothrix						65		65
Oscillatoria					196	65		
Stichosiphon	65		65				65	65
Unidentified				65				
Green Algae								
Ankistrodesmus				65				
Antinastrum			65					
Chlorella-like		130	130		130	65		
Coelastrum					65			
Pediastrum				65	130			
Scenedesmus	65	130	65	65	65	65		
Protozoa								
Ceratium						65		65
Diatoms								
Asterionella	158	788	788	158	472	1576	158	158
Cyclotella	14806	12128	11182	9766	8820	10552	15278	13702
Cymbella	316				158			
Gomphonema		158	158		158		472	
Melosira	472	472	316	316		158		158
Navicula	788	1576	946	788	139388	2992	1102	472
Nitzschia	1102	3466	1102	1890	418636	10396	3780	1260
Stauroneis		158						
Stephanodiscus	316	316	1102	316	472	316	630	158
Suriella		316		158		158	316	158
Synedra		158			25988	946		316
Total	18088	21226	15919	13652	594743	27484	21801	16577

Source : Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 15 OF 31)

DATE:
SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
(counts/liter river water)
October 8, 1974

Sampling Sites:

	Neal IV	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae								
Anacystis			65					
Oscillatoria		65	65					
Stichosiphon		65	65					65
Green Algae								
Actinastrum	65		65	65		65		65
Ankistrodesmus			130					
Chlorella-like	196	65	130		65	261		65
Coelastrum		65				65		
Scenedesmus		65						
Diatoms								
Asterionella	316	472	630	630	472	316	630	472
Cocconeis	316							
Cyclotella	6458	4568	5984	5512	3938	3464	5198	6142
Cymbella					158	316	316	
Diatoma		158	158				158	
Fragilaria	316					316		
Melosira			158					158
Navicula	1574	1732	1418	1260	2048	788	630	1260
Nitzschia	630	1890	1102	1260	2362	1574	2204	472
Stephanodiscus	472	630	158			316	472	472
Suriella	316			158	158		158	158
Synedra					158			158
Protozoa								
Amoeba	65					65		
Crustacea								
Cyclops				65				
Total	10724	9775	10128	8950	9359	7546	9766	9487

Source : Hey and Baldwin 17/

envirosphere company

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 16 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON

(counts/liter river water)

November 5, 1974

Sampling Sites:

	Neal IV	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae								
Oscillatoria	261							
Green Algae								
Actinastrum								130
Chlorella-like	130	130	65					
Scenedesmus		130					130	
Protozoa								
Actinophrys			65					
Flagellates				65				
Unidentified		196						
Diatoms								
Asterionella						158	158	
Cyclotella	4094	7244	6930	4410	5670	6772	6142	3150
Cymbella						472	630	
Diatoma				158			158	158
Gomphonema		472		158				
Melosira			316					
Navicula		316	316	472	158	788	472	158
Nitzschia	158	158	158	158	316	316	316	472
Stauroneis	158			472	630	158		
Stephanodiscus	788	944	1890	472		472	1260	158
Synedra						158		
Suriella						316		
Total	5589	9590	9740	6365	6774	9610	9266	4226

Source : Hey and Baldwin 17/

envirosphere company

A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 17 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON
(counts/liter river water)
December 3, 1974

Sampling Sites:

	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae							
Oscillatoria	130		130	717			
Stichosiphon			130		65		
Green Algae							
Chlorella-like	65			196		65	
Pediastrum							65
Protozoa							
Ceratium		65					
Diatoms							
Asterionella	3308	3780	2520	472	1260	2992	2992
Cyclotella	6142	6458	5198	5984	6300	4524	8348
Diatoma			158	158		158	158
Fragilaria	158		316	2362	944	630	630
Gomphonema			158				158
Gyrosigma					158		
Melosira					158		
Navicula	630	158	1418	7718	630	1102	158
Nitzschia	630	630	1418	9292		472	158
Stauroneis			158				158
Stephanodiscus	1260	630	788		472	630	788
Suriella	158				158		
Synedra	158						
Crustacea							
Cyclops				65			65
Diaptomus						130	
Total	14069	11721	12392	26964	10145	10703	13678

Source : Hey and Baldwin[17/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 18 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
(counts/liter river water)
January 7, 1975

Sampling Sites:

	#1	#2	#3	#4	#5	#6	#8
Diatoms							
Asterionella	4323375	3674335	3317790	3610285	3588935	3450160	3326330
Cyclotella	136640	143045	138775	51240	72590	46970	117425
Cymbella				2135			
Diatoma	2135	4270	8540	81130	4270	6405	6405
Fragilaria	6405	8540	10675	10675		4270	12810
Gomphonema	2135	19215					2135
Melosira					2135	4270	
Navicula	2135	23485	10675	228445	21350	10675	4270
Nitzschia	17080	102480	17080	239120	17080	6405	6405
Stauroneis					4270	2135	2135
Stephanodiscus	160125	130235	241255	333060	290360	251930	198555
Suriella	2135	14945	4270			4270	2135
Synedra		12810			2135		
Total	4652165	4133360	3749060	4556090	4003125	3787490	3678605

Table 30

February 11, 1975

Sampling Sites:

	#1	#2	#3	#4	#5	#6	#8
Diatoms							
Asterionella	2058140	2036790	2724260	2719990	2647400	2015440	2060275
Cyclotella	42700	34160	61915	40565	34160	34160	12810
Diatoma				2135	2135	2135	4270
Fragilaria			2135		2135		
Gomphonema			2135				
Melosira					2135		
Navicula	2135	4270	8540	8540	2135		29890
Nitzschia	6405	12810	14945	4270	4270	6405	19215
Stauroneis		2135	2135				
Stephanodiscus	4270	2135	42700	42700	42700	42700	29890
Total	2113650	2092300	2858765	2818200	2737070	2100840	2156350

Source : Hey and Baldwin[17]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 19 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON
(counts/ liter river water)

March 6, 1975

Sampling Sites:

	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae							
Stichosiphon					130		
Green Algae							
Chlorella-Like						65	
Scenedesmus						65	
Stigeoclonium			65				
Protozoa							
Unidentified Green Flagellates							65
Diatoms							
Asterionella	181912	194354	149782	68040	85208	188212	203018
Cyclotella	1260	630	630		314	314	314
Cymbella		158					158
Diatoma	2048	1890	1890	158	472	472	1574
Fragilaria	2204	1732	3308	2048	788	1418	5670
Gomphonema		630	1574	158		314	472
Melosira	158	158	158		158		314
Navicula	944	20790	7560	472		944	12442
Nitzschia	7718	10552	10080	1260		158	788
Stephanodiscus	158	630	158	158	158	788	314
Suriella	158	472	472				
Synedra	158						
Pleurosigma		314					
Crustacea							
Cyclops		65				65	
Diaptomus			65		65		
Total	196718	232375	175742	72294	87293	192815	225129

Source : Hey and Baldwin [17/]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 20 OF 31)

DATE: SCALE:

TABLE

A-III-C-1

(Cont'd)

PLANKTON
(counts/liter river water)
April 1, 1975

Sampling Sites:

	#1	#2	#3	#4	#5	#6	#8
Green Algae							
Chorella-Like		65			65		
Scenedesmus					65		
Stigeoclonium				130			
Ulothrix							65
Protozoa							
Unidentified Green Flagellates							65
Diatoms							
Asterionella	13702	21578	8820	35594	11654	25514	24098
Cyclotella	2048	2362	4094	5354	4724	4252	5198
Cymbella					314	158	
Diatoma	788	2204	788	314	158	630	1102
Fragilaria	788	1418	630	2204	1418	1574	1732
Gomphonema		158					158
Gyrosigma						158	
Melosira	314	158				158	
Navicula	788	944	944	2204	1102	1732	3464
Nitzschia	314	158	1574	1260	1260	1260	2520
Stauroneis		158					
Stephanodiscus				630		158	
Suriella	314	158	158	314	158	314	
Synedra		158			158		
Pleurosigma						158	
Crustacea							
Cyclops							65
Diaptomus		65					
Total	19056	29584	17008	48004	21076	36066	38467

Source : Hey and Baldwin [17]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 21 OF 31)

DATE:

SCALE:

TABLE

A-III-C-1

(Cont'd)

PLANKTON
(counts/liter river water)
May 6, 1975

Sampling Sites:	#1	#2	#3	#4	#5	#6	#8
Blue-Green Algae							
Stichosiphon							65
Green Algae							
Chlamydomonas	130	65	130		196	65	196
Chlorella-Like			65	65	65	130	65
Chlorococcum	65						
Pediastrum	65					65	
Scenedesmus	196	65		196	326	65	65
Protozoa							
Coleps							65
Rotifers					65		
Diatoms							
Asterionella	48038	120488	58432	26774	47880	172934	148994
Cyclotella	43628	53078	25042	16064	29452	56700	46778
Cymbella			158			314	
Diatoma		314	472	314	314	630	1574
Fragilaria	3780	7718	6300	3464	4882	5354	5828
Gomphonema		158		314			
Melosira	158	944		2204	788	630	944
Navicula	1890	1890	1418	2834	1890	944	1890
Nitzschia	2204	4724	2678	3150	2204	6614	4152
Stauroneis			158			630	
Stephanodiscus	1890	2992	1102	630	630	1890	2048
Suriella	314	158	472		314	630	158
Synedra	314		472	314			314
Pleurosigma			158				314
Crustacea							
Cyclops	65						
Total	102737	192594	97057	56323	89006	247595	213450

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 22 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON
(counts/liter)
June 4, 1975

Site:	1	2	3	4	5	6	8
Blue-Green Algae							
Anabaena		65					
Anacystis	520	260	65			325	260
Oscillatoria		260		4355	65		
Green Algae							
Actinastrum	1885	130	260		65	325	130
Ankistrodesmus			65				
Chlorella-like	390	65	65		65		
Closterium	195						
Coelastrum	1430		585	455		390	
Micractinium	130						
Oocystis					65	130	65
Pediastrum	455	130	65	65	65	260	
Scenedesmus	3055	1105	1105	260	455	2210	650
Staurastrum	130	65					
Unidentified	130	65	130		130	195	260
Diatoms							
Asterionella	775008	853320	776256	555360	637104	653016	433680
Cocconeis				2340			
Cyclotella	6552	3120	2184	5460	1248	4680	1560
Cymatopleura		312					
Cymbella				3900		624	312
Diatoma		624		780		312	
Fragilaria	5304	16848	5616	28860	9360	6240	5928
Gomphonema	312				312		
Melosira	85488	62712	63024	60840	43992	69576	23088
Navicula	1560	624	312	4680	312	1872	312
Nitzschia	932	936	936	336180		3120	312
Pleurosigma		312	312	780		624	
Stephonodiscus	3120	1248	3432	3120	624	2496	1248
Suriella	312			780	312	624	
Synedra	1872	312	624	17940	1248	312	624
Protozoa							
Actinophrys	130			65			
Amoeba				1170			
Dinobryan	195	130	260				65
Euglena					65		
Crustaceans							
Larval Watermite				65			65
Rotifers				65	65	65	65
Colonial Rotifer					975		
Total	889105	942643	855296	1027520	696527	747396	468624

Source : Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 23 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
(counts/liter)
July 1, 1975

Site:	1	2	3	4	5	6	8
Blue-Green Algae							
Anabaena		130				130	
Anacystis	130	260	130	260			
Oscillatoria				130			
Stichosiphon		260					
Unidentified	130	130			130	780	260
Green Algae							
Actinastrum	65		130	130			130
Closterium			130				
Coelastrum				130			
Oocystis	195	130	390	390			
Pandorina	130	130	390	130		260	
Pediastrum	65	260	130	130	130		
Scenedesmus	585	1560	1560	1560	1040		520
Staurastrum	130	130					
Unidentified	65	390	390		650	520	520
Diatoms							
Asterionella	34632	26520	23712	14040	69576	76440	50856
Cyclotella	18720	22776	22464	28704	23400	4680	2496
Cymbella	624	312				624	312
Diatoma	312						
Epithema		312					
Fragilaria	6864	7800	6864	5928	7176	11856	14664
Gomphonema	312			624	312		
Melosira	8424	13728	7800	6552	14976	17472	38376
Navicula		312	624		312		312
Nitzschia	1560	624	2184	5928	1248	624	1248
Pleurosigma				312	312		
Stephanodiscus		936	624	2184	4368	1248	4056
Suriella							312
Synedra	1248	624		936			936
Protozoa							
Difflugia					130		
Euglena	65						
Unidentified	130	390	130	130	130		
Total	74386	77714	67652	68198	123890	114634	114998

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 24 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON
(counts/liter river water)
August 4, 1975

Sampling Sites:	1	2	3	4	5	6	8
Blue-Green Algae							
Anacystis		130	65		65	130	65
Stichosiphon	65	130	325	260	260	260	195
Green Algae							
Actinastrum		325	260	520	130	455	195
Ankistrodesmus	65	65					65
Chlorella-like		130	65	65			
Coelastrum	130	130	65	130	130	130	650
Pandorina		65		65			
Pediastrum		65		65			
Scenedesmus	195	520	260	585	715	585	195
Unidentified Green	130	325	260	195	195	260	65
Selenastrum		65					
Staurastrum						65	
Diatoms							
Asterionella		156	312		156		156
Cyclotella	4992	6552	15132	9204	11856	11856	11856
Cymbella		312					156
Diatoma				156			
Fragilaria	468	156		1092	624	780	468
Gomphonema			312	156			
Melosira	1872	2964	2652	936	1248	3744	2652
Navicula	624	936	936	156	624	312	156
Nitzschia	1560	156	2028	1404	312	2496	624
Stephanodiscus	312	156	1092	468	468	468	468
Suriella						156	
Synedra	156	312	156				
Amphipleura			156				156
Cocconeis				156	312		
Total	10569	13650	24076	15613	17095	21697	18122

Source : Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 25 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

PLANKTON
September 3, 1975
counts/liter

Site:	1	2	3	4	5	6	8
Blue-Green Algae							
Oscillatoria		130					
Stichosiphon			65	130		130	
Anacystis					65		
Green Algae							
Actinastrum	65		65				
Chlorella-like			65		130		
Pediastrum	260	65	65	260			
Scenedesmus	65	65	130	130	65	130	195
Protozoa							
Vorticella			65				
Diatoms							
Achnanthes		200		468		200	
Asterionella			66	200	3818		
Cocconeis	200	200		134	134		134
Cyclotella	5024	4958	1942	6030		5292	4288
Cymbella			134				
Diatoma		134	66		66	200	66
Fragilaria	524	736	200	334	334	402	402
Gomphonema	66	66	66		66		200
Melosira	602	1272	804	536	536	468	468
Navicula	268	670	134	5024	334	804	468
Nitzschia	1072	870	1004	2344	804	1406	1072
Pleurosigma					134		
Rhoicosphenia	268	134				66	
Stephanodiscus		200	134	66	66		
Suriella				66			
Synedra		66			66	66	66
Total	8414	9766	5005	15722	6618	9164	7359

Source : Hey and Baldwin [17/]

envirosphere company

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 26 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
October 7, 1975
counts/liter

Site:

	1	2	3	4	5	6	8
Blue-Green Algae							
Oscillatoria			130	65		65	
Stichosiphon	195		455				65
Green Algae							
Ankistrodesmus				130			65
Chlorella-like		130				65	65
Cladophora					65		
Closterium						65	
Scenedesmus			130			65	
Diatoms							
Achnanthes	200						200
Amphipleura			66				
Asterionella			66	66			
Cocconeis	200	66	334		134		66
Cyclotella	402	1138	870	1742	1206	1138	1540
Cymbella							128
Diatoma	402	200	134	402	134		
Epithemia	66						
Fragilaria	268	66	468	66	268	200	536
Gomphonema	134	66	200		66		
Melosira	468	536	602	402	334	334	334
Navicula	334	670	536	804	670	1808	1942
Nitzschia	736	1474	1474	1272	1206	1474	1742
Rhoicosphenia	66	66					66
Stephanodiscus	200	334		200	66	134	134
Synedra			66				
Total	3671	4746	5531	5149	4149	5348	6883

Source : Hey and Baldwin[17/]

envirosphere company A DIVISION OF EBASCO SERVICES INCORPORATED	IOWA PUBLIC SERVICE Co. - NEAL UNIT 4 PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 27 OF 31) DATE: SCALE:	TABLE A-III-C-1 (Cont'd)

PLANKTON
November 10,1975
counts/liter

Site:	1	2	3	4	5	6	8
Blue-Green Algae							
Anacystis						130	
Green Algae							
Chlorella-like		130		130			
Closterium						130	
Spirogyra					910		
Ulothrix						390	
Unidentified green filament		260					
Tetraspora						130	
Protozoa							
Amoeba						260	
Cyclops			130				
Unidentified green flagellates						390	
Vorticella						130	
Diatoms							
Asterionella	308200	253126	223110	146730	415400	329908	300830
Cocconeis	134	134	134		402	134	
Cyclotella	3484	4020	1608	2546	804	3082	3752
Cymatopleura			134				
Cymbella	268	268	134	134		402	134
Diatoma	670	536	134	134	134	268	134
Fragilaria	3752	3082	3886	3886	8576	5092	6164
Melosira	4154	5494	8978	4154	4556	8308	6164
Navicula	402	670	804	670	670	402	134
Nitzschia	536	1340	1072	1608	1608	1742	2010
Stephanodiscus		2546	1608	938	1742	2278	938
Synedra	134				268		
Total	321734	271606	241732	160930	435070	353176	320260

Source : Hey and Baldwin [17]

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 28 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

PLANKTON
December 10, 1975
counts/liter

Site:	1	2	3	4	5	6	8
Blue-Green Algae							
Oscillatoria					195		
Green Algae							
Unidentified						130	195
Diatoms							
Asterionella	25326	14807	35912	13735	21172	18827	5561
Cocconeis							67
Cyclotella	1273	536	1608	1005	469	737	536
Cymbella							67
Diatoma	67		134	67			67
Fragilaria	1809	938	2412	1474	938	1072	268
Gomphonema			134	67	201	67	
Melosira				134	402		134
Navicula	67	67	402	67	268	132	67
Nitzschia	1072	1675	1072	335	4288	1320	670
Rhoicosphenia					201		
Stauroneis	67						
Stephanodiscus	268	67	536	268	67	469	201
Suriella		67					
Synedra		67					
Crustacea							
Cyclops				65			
Total	29949	18224	42210	17217	28201	22754	7831

Source : Hey and Baldwin [17/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4	TABLE
PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 29 OF 31)	A-III-C-1
DATE: SCALE:	(Cont'd)

ZOOPLANKTON
(counts/liter)

1975	June 10			June 19			June 26		
Site:	2	5	6	2	5	6	2	5	6
Crustaceans									
Adult Cyclopoids			2	1	2	2	8	2	2
Adult Calanoids	2	36	5	1	1	1	1	1	
Copepodites									
Calanoid	5	7							
Cyclopoid		13	12	6	8	2	14	20	22
Unknown			1					1	
Nauplii									
Calanoid		7					2		
Cyclopoid	13	29	19	18	28	25	19	11	12
Unknown	2	2	1						
Cladocera									
Bosmina longirostris			1			1	1	1	
Daphnia pulex	2	5				1			
Unknown		16							
Rotifers									
Brachionus angularis		2	1	7	12	11	38	26	60
Brachionus calyciflorus	4	16	4	4	11	2			2
Brachionus quadridentata						1			
Brachionus urceolaris	4	2	1	1				1	
Pelinia				1	2	1			
Keratella cochlearis	4	14	31	12	13	19	10	17	43
Keratella quadrata				1					
Monostyla				1	1				
Notholca striata				1		2			
Polyarthra				6	5	4	1	2	
Unknown		2	1	16	6	6		5	5
Protozoa									
Ceratium				2	7	4	2	2	
Difflugia	49	124	102	62	44	91	121	271	211
Unknown		9							
Tardigrada				1					
Total	85	284	181	141	140	173	217	360	357

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 -
DECEMBER 10, 1975 (SHEET 30 OF 31)

DATE: SCALE:

TABLE
A-III-C-1
(Cont'd)

ZOOPLANKTON
(counts/liter)

1975	July 3			July 17			Aug 14		
Site:	2	5	6	2	5	6	2	5	6
Crustaceans									
Adult Calanoids						1			
Adult Cyclopoids		4		1					
Copepodites									
Cyclopoid	12	14	8	1	1	1		2	1
Nauplii									
Cyclopoid	2	11	4	4	2	5		2	
Cladocera									
Bosmina longirostris		1							
Daphnia								2	
Unknown							1	1	
Rotifers									
Brachionus angularis	6	4	8	11	23	16		1	
Brachionus calyciflorus		2	2	1	1	1			
Brachionus furchlatus				1					
Brachionus urceolaris	2	2							
Hexartha					1				
Keratella cochlearis	5	2	6		1	2	1	1	
Monostyla	4	1				1			
Notholca striata			1						
Notommata							1		
Polyarthra	6	2	6	1	2	2			1
Synchaeta							2	7	17
Unknown	11	18	4	1	2	1		1	2
Protozoa									
Centropyxis aculeata								2	
Ceratium	4			2		1	4	1	
Difflugia	54	31	122	2	11	18	2	1	
Total	106	90	161	25	44	49	11	21	21

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PLANKTON DATA, MAY 14, 1973 - DECEMBER 10, 1975 (SHEET 31 OF 31)

DATE: SCALE:

TABLE A-III-C-1 (Cont'd)

TABLE A-III-C-2

NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE DRIFT NET SAMPLES

MARCH 1973 - AUGUST 1974

March 29, 1973	(est current vel = 1.64 ft/sec; vol = 16,561 gal)	
	Diptera (midges)	8
	Coleoptera (beetles)	2
	Hemiptera (bugs)	10
	Malacostraca (water fleas)	1600
	Gastropoda (snails)	2
April 12, 1973	(est current vel = 1.68 ft/sec; vol = 11,310 gal)	
	Trichoptera (caddis flies)	3
	Diptera (midges)	31
	Coleoptera (beetles)	9
	Malacostraca (water fleas)	1000
April 26, 1973	(est current vel = 1.82 ft/sec; vol = 18,378 gal)	
	Diptera (midges)	240
	Coleoptera (beetles)	2
	Hydracarina (mites)	1
	Malacostraca (water fleas)	800
	Gastropoda (snails)	2

Source: Hey and Baldwin [15]/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE (3) DRIFT NET SAMPLES FROM MARCH 1973 THROUGH AUGUST 1974
(SHEET 1 OF 6)

DATE: SCALE:

TABLE
A-III-C-2

May 11, 1973	(est current vel = 1.68 ft/sec; vol = 16.965 gal)	
	Diptera (midges)	45
	Coleoptera (beetles)	3
	Hemiptera (bugs)	8
	Malacostraca (water fleas)	2500
	Gastropoda (snails)	2
May 23, 1973	(est current vel = 1.82 ft/sec; vol =18.378 gal)	
	Ephemeroptera (mayflies)	2
	Diptera (midges)	161
	Coleoptera (beetles)	10
	Hemiptera (bugs)	2
	Malacostraca (water fleas)	15000
	Hydrazoa (hydras)	35
	Fish	5
June 6, 1973	(est current vel = 1.82 ft/sec; vol = 18.378 gal)	
	Ephemeroptera (mayflies)	1
	Diptera (midges)	4
	Coleoptera (beetles)	3
	Hemiptera (bugs)	5
	Malacostraca (water fleas)	3000
	Hydrazoa (Hydras)	3
	Fish	3

Source: Hey and Baldwin [15]/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE (3) DRIFT NET SAMPLES FROM MARCH 1973 THROUGH AUGUST 1974
(SHEET 2 OF 6)
DATE:
SCALE:

TABLE
A-III-C-2
(Cont'd)

June 20, 1973	(est current vel = 1.92 ft/sec; vol = 19,388 gal).	
	Trichoptera (caddis flies)	1
	Ephemeroptera (mayflies)	3
	Diptera (midges)	23
	Coleoptera (beetles)	4
	Hemiptera (bugs)	37
	Hydracarina (mites)	1
	Malacostraca (water fleas)	8000
	Gastropoda (snails)	11
	Fish eggs	1
	Fish larvae and young of year	161
July 5, 1973	(est current vel = 1.87 ft/sec; vol = 18,887 gal).	
	Trichoptera (caddis flies)	3
	Diptera (midges)	1
	Coleoptera (beetles)	1
	Malacostraca (water fleas)	9000
	Fish larvae	29
July 18, 1973	(est current vel = 1.92 ft/sec; vol = 19,388 gal).	
	Trichoptera (caddis flies)	6
	Ephemeroptera (mayflies)	9
	Diptera (midges)	21
	Hemiptera (bugs)	1
	Malacostraca (water fleas)	7000
	Gastropoda (snails)	5
	Fish larvae	3

Source: Hey and Baldwin [15/]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE (3) DRIFT NET SAMPLES FROM MARCH 1973 THROUGH AUGUST 1974
(SHEET 3 OF 6)

DATE:
SCALE:

TABLE A-III-C-2 (Cont'd)

July 31, 1973	(est current vel = 1.87 ft/sec; vol =18.887 gal)	
	Trichoptera (caddis flies)	6
	Diptera (midges)	8
	Coleoptera (beetles)	2
	Hemiptera (bugs)	3
	Malacostraca (water fleas)	1900
	Gastropoda (snails)	9
	Hydrazoa (Hydras)	22
August 13, 1973	(est current vel = 1.87 ft/sec; vol = 18.887 gal).	
	Trichoptera (caddis flies)	1
	Ephemeroptera (mayflies)	1
	Diptera (midges)	3
	Hemiptera (bugs)	1
	Malacostraca (water fleas)	3000
	Pelecopoda (clams)	6
	Hydrazoa (Hydras)	1
September 10, 1973	(est current vel = 1.87 ft/sec; vol = 18.887 gal)	
	Trichoptera (caddis flies)	4
	Ephemeroptera (mayflies)	1
	Diptera (midges)	[illegible]
	Malacostraca (water fleas)	1200
	Gastropoda (snails)	1
May 10, 1974	(current vel = 1.2 ft/sec; 12.118 gal)	
	Diptera (midges)	2
	Malacostraca (water fleas)	> 3000

Source: Hey and Baldwin [15]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE (3) DRIFT NET SAMPLES FROM MARCH 1973 THROUGH AUGUST 1974

(SHEET 4 OF 6)

DATE: SCALE:

TABLE A-III-C-2 (Cont'd)

May 16, 1974	(current vel = 1.8 ft/sec; vol = 18,176 gal).	
	Trichoptera (caddis flies)	1
	Diptera (midges)	29
	Malacostraca (water fleas)	>3000
	Hydrazoa (hydras)	1
	Fish larvae	4
May 23, 1974	(current vel = 1.8 ft/sec; vol = 18,176 gal).	
	Diptera (midges)	6
	Malacostraca (water fleas)	>3000
	Fish larvae	98
	Fish eggs	2
May 30, 1974	(current vel = 1.8 ft/sec; 18,176 gal).	
	Diptera (midges)	9
	Malacostraca (water fleas)	>3000
	Gastropoda (snails)	5
	Nematoda (roundworms)	1
	Fish larvae	9

Source: Hey and Baldwin 15/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE (3) DRIFT NET SAMPLES FROM MARCH 1973 THROUGH AUGUST 1974
(SHEET 5 OF 6)
DATE: SCALE:

TABLE
A-III-C-2
(Cont'd)

DRIFT NET DATA [1]

June 1974 - August 1974

Date:	6/7	6/14	6/20	6/27	7/3	7/10	7/18	7/26	8/2
Insecta									
Diptera									
Chironomid larvae	5	6	15	6	3	1		5	4
Chironomid pupae	7	3	5	1	2	3	1	2	6
Simuliidae			1	1		1			1
Ephemeroptera									
Isonychia		1	5	2	4	4	1	1	
Stenonema	1	1							
Trichoptera									
Hydropsychidae			1	3	1	2		1	
Rhyacophilidae						2			
Gastropoda							1	4	
Microcrustaceans	153750	82800	178800	187200	181500	90750	120000	216000	45198
Nematodes									
Hydra	225	150							
Larval Fish	8	21	10	57	33	7	9	5	1

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[1] Data represents a composite of three 5-minute samples taken just above IPS plant along the Iowa shore.

Source : Hey and Baldwin17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
NUMBERS AND KINDS OF ANIMALS COLLECTED IN REPLICATE (3) DRIFT NET SAMPLES FROM MARCH 1973 THROUGH AUGUST 1974
(SHEET 6 OF 6)
DATE:
SCALE:

TABLE
A-III-C-2
(Cont'd)

TABLE A-III-C-3

ARTIFICAL SUBSTRATE DATA -
VICINITY OF NEAL UNITS 1-4
APRIL 1973 - NOVEMBER 1975

Reproduced from best available copy.

APRIL 17 - MAY 17, 1973

Organism	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23	24
	Substrate Number																				
Insecta																					
Trichoptera																					
Hydropsychidae	1	55	2	9	10	1	16	10	17	2		1	11	9	6	7	11	33	5	13	23
Rhyacophilidae		2	1	4	5		3	2					8	3	5	8	3	11	10	23	10
Leptoceridae		3		1			1			1	1	2							1	2	
Ephemeroptera																					
Caenis			1	6	4		5	3	2	1	2	1	1			1	2			2	1
Isonychia																					
Stenonema	4	6	1	9	10		15	7	1	2	5	4	6	8	2	8	3	6	20	2	9
Heptagenia																					
Potamanthus					1			6	1				4								
Tricorythodes																					
Diptera																					
Chironomid pupae		5	12	6	15	5	12	20	4	6	6	12	10	15	2	10	8	5	3	3	1
Chironomid larvae	45	85	60	95	75	55	85	250	60	35	30	160	50	125	21	100	100	75	50	80	45
Polypedilum 1.																					
Simuliidae		2	1	10		2	10	30	35		8	13	7	5	11		1		1	2	
Anthomyiidae				2					1								1				
Plecoptera																					
Alloperla																					
Paragnetina						1	4	2		1	1	2	8	9	2	13	8	12	25	8	12
Acroneuria		5		3				15					7	1	1						
Coleoptera																					
Dytiscidae																					
Hydrophilidae																					
Hemiptera																					
Corixidae																					
Odonata																					
Anisoptera																					
Gomphus																					
Zygoptera																					
Amphiagrion					1																
Arachnida																					
Hydracarina						1		1													
Crustacea																					
Asellus				4	1								33	45	11	3	1			2	1
Hyalella																					1
Daphnia	15	10		10				3		3	2		5		2		5	5	3	6	5
Gastropoda																					
Pelecypoda																					
Sphaerium																					
Oligochaeta																					
Hirudinea																					
Nematoda	25	25	20		8	20	80	15	5	15	2			3		2	3	3			
Turbellaria																					
Planaria															1						
Hydrozoa																					
Hydra					8	2	3	2		1					10	5	10		2		

Source: Hey and Baldwin[14].

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

ARTIFICIAL SUBSTRATE DATA

APRIL 1973 - NOVEMBER 1975
(SHEET 1 OF 35)

DATE:

SCALE:

TABLE
A-III-C-3

MAY [illegible] – JUNE 18, 1973

Organism	Substrate Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Insecta																		
Trichoptera																		
Hydropsychidae	2	17	8	2			5	21	17	14	16	2	1	8				10
Rhyacophilidae	27	75	75	50	27	7	30	55	85	57	77	35	90	61	32	80	200	100
Ephemeroptera																		
Caenis	3	2		3	3	3	6	5		2				1		2		
Isonychia	4	1	1	1	2	1	4	9	20	1	17	4	4	4	2	9	20	2
Stenonema	4	3	1	5	17		11	11	5	4	14	3	3	1	1	10	3	
Heptagenia					1	1		1										
Pentagenia																		
Tricorythodes																		
Hexagenia		2	1	9	2	1	7	2	7	1	1	2		1		2		
Diptera																		
Chironomid pupae	2	1	4	3	3	2	2	3	5	10	2	5	3	3	5	3	7	5
Chironomid larvae	15	18	30	35	40	25	18	[illegible]	15	25	18	19	3	4	10	35	60	15
Polypedium l.																		
Simuliidae								1										
Anthomyiidae																		
Ceratopogonidae	1																	
Plecoptera																		
Alloperla																		
Paragnetina		1					2	4	6	1	3		3				4	6
Acroneuria		1						12	5							2	5	7
Coleoptera																		
Dytiscidae								1										
Hydrophilidae																		
Hemiptera																		
Corixidae													1					
Notonectidae											1							
Odonata																		
Anisoptera																		
Gomphus																		
Zygoptera	1																	
Arachnida																		
Hydracarina																		
Crustacea																		
Asellus	3	5	3	1	1		4	2	1	1		1	4	5	8	13	2	
Hyalella	2	1						3		2	3		1			2		
Daphnia	10	10	5		5			15		45	10				5		5	
Decapoda				1	1	3	2			1						1	5	1
Gastropoda	3	1		1						2						1		
Pelecypoda																		
Sphaerium							3	1	3		1	1						4
Oligochaeta																		
Hirudinea																	1	
Nematoda	20	50	30			5	20				25			25				
Turbellaria																		
Planaria																		
Hydrazoa																		
Hydra				350	125	75	1500	200	160	50	20	20	35	750	200	750	800	100
Fish larvae	1		1	1						1	1	1						

Source: Hey and Baldwin 14/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

ARTIFICIAL SUBSTRATE DATA

APRIL 1973 - NOVEMBER 1975

(SHEET 2 OF 35)

DATE:

SCALE:

TABLE A-III-C-3

Organism	JUNE 19 – JULY 19, 1975																				
	Substrate Number																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23	24
Insecta																					
Trichoptera																					
Hydropsychidae	1	72	20	26	9	3	33	75	60	45	32	6	8	80	1	6	13	200	190	750	250
Rhyacophilidae	15	41	65	45	54	45	62	125	120	60	75	42	50	125	45	150	60	200	100	200	250
Leptoceridae				3		1					1	2			1						
Ephemeroptera																					
Caenis		31	14	18	20	32	21	16	72	55	23	30	7	18	6	11	8	7	100	62	20
Isonychia	2		1	2	2	1	7	65	72	27	33	9		5	3	4	5	6	60	85	45
Stenonema	8	5	11	10	28	43	50	22	16	96	31	55	3	9	10	3		1	3		5
Heptagenia																					
Pentagenia			1			1		3	3									1		2	
Tricorythodes		1	1	1	5	1	2		4	2	1	4		3		1	2	1			1
Hexagenia									1												
Diptera																					
Chironomid pupae	4	1	1	3	3	3	2	1	3	8	2	6		2	5	2	3		5	1	4
Chironomid larvae	15	24	12	15	25	31	32	26	27	21	14	18	4	25	31	45	13	8	10		30
Polypedilum I.																					
Simuliidae			1						2				9	7					1		1
Anthomyiidae			1		4	1		4	1			1		3	3	1	1				
Unknown larvae					1		2										1				2
Plecoptera																					
Alloperla																					
Paragnetina																			2		
Acroneuria																					4
Coleoptera																					
Dytiscidae																					
Hydrophilidae																					
Hemiptera																					
Corixidae																					
Odonata																					
Anisoptera					1																
Gomphus																		1			
Zygoptera		1																			
Arachnida																					
Hydracarina																					
Crustacea																					
Asellus			3	2	4	2	2		4	3	2	8	9	60	85	9	2	3			
Hyalella												2									
Daphnia	6		10						3	3	5		20		10	15	5	5			3
Decapoda					4	1			1	1	3	1	1			1	1				
Gastropoda					2							1				4	1		1		1
Pelecypoda																					
Sphaerium		1	1	3	3	1	2		2			2						8			
Oligochaeta																					
Hirudinea		1			1		1				1	1		2	8		1				
Nematoda		3	3	5	12				3	6	3	3		5							
Turbellaria																					
Planaria		3	2	20	26	4	40	25	20		1	1	20	9	3	8	5	75			
Hydrozoa																					
Hydra		3	7	55	15	4	55	20	15	16	5	7	15	6	60	6	3	10			

Source: Hey and Baldwin 16/

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
ARTIFICIAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 3 OF 35)

DATE:

SCALE:

TABLE
A-III-C-3
(Con'd)

JULY 20 - AUGUST 15, 1973

Organism	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23	24
	Substrate Number																				
Insecta																					
Trichoptera																					
Hydropsychidae	2	52	6	9	11	2	30	36	30	45	35	9	25	20		7	55	85	50	125	70
Rhyacophilidae	35	56	10	23	20	10	25	20	25	40	15	19	45	65	25	25	50	45	20	30	30
Leptoceridae														1							
Hydroptilidae												1									
Ephemeroptera																					
Caenis	4	8	7	9	6	5	3	5	6	8	4	5	6	5	7	2	1	25	6	9	10
Isonychia		11	1	5		1	16	20	24	20	29	4	15	4	1	3	55	100	72	125	225
Stenonema	15	10	9	6	2	19	30	20	25	26	10	10	15	11	30	5	25	5	6	9	25
Heptagenia																					
Potamanthus																		1			
Tricorythodes			2		1		1	2		2		1	2		1	1	2	1			
Hexagenia	1																				
Diptera																					
Chironomid pupae	3	3	6	11	5	2	2	1	1	[illegible]	2	8	5	12		1	5	5		1	1
Chironomid larvae	15	25	12	25	13	10	15	15	15	25	15	22	17	27	15	7	25	10	5	20	6
Polypedilum 1.																					
Simuliidae																					
Anthomyiidae	1	1			1	5					1	1	7					1		5	2
[illegible]														2	1	1	1				
Plecoptera									1	1					1	2		2			
Alloperla																					
Paragnetina																					
Acroneuria																					
Coleoptera																			1	1	
Dytiscidae																					
Hydrophilidae																					
Odonata																					
Anisoptera																					
Gomphus																					
Zygoptera	1			1	1																
Annelida																					
Hydracarina																					
Crustacea																					
Asellus	5	5	1	1		1	2			1	1		11	21	55	6	1	2			
Hyalella						1															
Daphnia					5							5							1		
Decapoda	1			1		1											4		1		1
Gastropoda	1																				
Pelecypoda																					
Sphaerium		1	4	5	2		5	2	5	2		4				1		2			
Oligochaeta																					
Hirudinea													1								
Nematoda				1	2																
Turbellaria																					
Planaria		10	1	23	13	30	20	25	25	6	8	4	35	21	15	65	5	50			
Hydrozoa																					
Hydra		8	4	15	20	8	100	8	10	5	2	10	4	17	5	10	5				

Source: Ray and Baldwin 16/

envirosphere company

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
ARTIFICIAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 4 OF 35)

DATE:

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TABLE
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(Cont'd)

AUGUST 15 – SEPTEMBER 30, 1973

Organism	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23
	Substrate Number																			
Insecta																				
Trichoptera																				
Hydropsychidae	35	400	390	85	15	10	25	23	58	35	36	78	85	60	25	25	60	50		25
Rhyacophilidae	53	50	36	16	22	8	11	6	8	4	15	19	90	60	25	15	35	50	10	25
Leptoceridae	1	3	1		1	1	1				1									
Pupae			8		2	3	2					-	3	4	4	7	3	5		
Ephemeroptera																				
Caenis	3	10	12	1	5				1		3	3				1				
Isonychia		30	40	8	9	3	2	8	20	6	16	31	7	13	8	95	30	25		100
Stenonema	10	24	8	17	16	26	16	2	15	26	23	45	10	8	5	10	3	30	8	15
Heptagenia																				
Pentagenia																				
Tricorythodes	2			1		2				1	3							1		
Hexagenia		2			1	1														
Diptera																				
Chironomid pupae	3	8		1	2	3		1	1	2	3	1						2		
Chironomid larvae	8	20	27	10	24	18	9	4	5	4	15	27	20	8	6	3	1	10	20	5
Polypedilum I.																				
Simuliidae		2													2					
Anthomyiidae						1														
Plecoptera																				
Alloperla																				
Paragnetina																				
Acroneuria																				
Coleoptera																				
Dytiscidae																				
Hydrophilidae																				
Hemiptera																				
Corixidae																				
Odonata																				
Anisoptera	1	3	1							4				1						
Gomphus																				
Zygoptera		1	1	2	3	3							1							
Annelida																				
Hydracarina																				
Crustacea																				
Asellus	15	2	2	1	2		3		1	1		1	10	9	4				2	
Hyalella		5				1													1	
Daphnia	10																			
Gastropoda						1	2		1			3								
Pelecypoda																				
Sphaerium	1	2	4	4	9	7	2	9	12	5		6			2	3		2		
Oligochaeta																				
Hirudinea			2			1														
Nematoda	7					1		3					1	3			1			
Turbellaria																				
Planaria	1	65	13	60	50	57	115	150	250	75	32	65	125	50	35	190	50	50	20	1
Hydrozoa																				
Hydra		20	3	45	60	15	20	50	45	15	2	4		4	3		3		30	3

Source: Hey and Baudoin 16/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
ARTIFICIAL SUBSTRATE DATA

APRIL 1973 - NOVEMBER 1975
(SHEET 5 OF 35)

DATE:

SCALE:

TABLE
A-III-C-3
(Cont'd)

SEPTEMBER 20 - OCTOBER 18, 1973

Organism	Substrate Number											
	2	3	4	5	7	8	9	10	13	14	15	24
Insecta												
Trichoptera												
Hydropsychidae	25	19	55	14	11	5	12	8	20	50	25	
Rhyacophilidae	16	19	25	7	9	2	2	1	10	20	13	5
Leptoceridae												
Pupae		1	2	2						2		
Ephemeroptera												
Caenis										1	1	2
Isonychia		1	3		1	1	9		3	6	2	3
Stenonema	6	8	30	8	20	3	25	1	7	9	2	17
Heptagenia												
Pentagenia												
Tricorythodes				2	1							
Hexagenia												
Diptera												
Chironomid pupae			1									
Chironomid larvae	7	4	13	9	1	1	1	4	17	14	8	13
Polypedilum I.												
Simuliidae												
Anthomyiidae												
Plecoptera												
Alloperla												
Paragnetina			1									
Acroneuria												
Coleoptera												
Dytiscidae												
Hydrophilidae												
Hemiptera												
Corixidae												
Odonata												
Anisoptera						1				3		
Gomphus												
Zygoptera	1			4						1	1	
Arachnida												
Hydracarina												
Crustacea												
Asellus	34	25	10	3	4		1	23	80	55	175	20
Hyalella									1	1		4
Daphnia												
Decapoda												
Gastropoda					1		1				1	1
Pelecypoda												
Sphaerium	2	2		4	5			3				
Oligochaeta												
Hirudinea												
Nematoda	1	1						1			1	
Turbellaria												
Planaria	19	1	25	11	40	34	65	2	20	33	50	8
Hydrazoa												
Hydra	15	5	4	-	4	1					3	4

Source: Hey and Baldwin 14/

envirosphere company

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

ARTIFICIAL SUBSTRATE DATA

APRIL 1973 - NOVEMBER 1975

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DATE:

SCALE:

TABLE
A-III-C-3
(Cont'd)

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OCTOBER 19 - NOVEMBER 15, 1973

Organism	1	2	4	5	6	7	8	9	10	11	13	14	15
Insecta													
Trichoptera													
Hydropsychidae	6	50	17	26	10	20	40	25	30	12	30	100	20
Rhyacophilidae		6	2	3	1	6	5	2		1	2	6	3
Leptoceridae													
Pupae			1										
Ephemeroptera													
Caenis													
Isonychia						1				1			
Stenonema	2	3	4	14	13	5	7	2	1	1	4	3	
Heptagenia													
Pentagenia													
Tricorythodes													
Hexagenia													
Diptera													
Chironomid pupae				1			2						
Chironomid larvae	9	6	5	7	5	3	3	2	7	2	2	1	2
Polypedilum 1													
Simuliidae													
Anthomyiidae													1
Plecoptera													
Alloperla													
Paragnetina													
Acroneuria													1
Coleoptera													
Dytiscidae													
Hydrophilidae													
Hemiptera													
Corixidae													
Odonata													
Anisoptera	1	1											
Gomphus												2	
Zygoptera	2		2	3	3		1						
Arachnida													
Hydracarina													
Crustacea													
Asellus	30	17	4	16	6	5	17	5	10	6	70	100	25
Hyalella													2
Daphnia													
Decapoda													
Gastropoda						2	2						
Pelecypoda													
Sphaerium	1	2	2	2		1			3		1		
Oligochaeta													1
Hirudinea		1		1									
Nematoda					2		3			2			
Turbellaria													
Planaria	1	3	3	4	[illegible]	13	50	30	2	3	6	2	5
Hydrozoa													
Hydra		1		1									

Source: Ney and Baldwin [14]

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

ARTIFICIAL SUBSTRATE DATA

APRIL 1973 - NOVEMBER 1975
(SHEET 7 OF 35)

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SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
Special Winter Sites
January 15 - February 15, 1974

*Substrate Numbers

Taxonomic group	1	2	2
Insecta			
Trichoptera			
Hydropsychidae	49	65	45
Rhyacophilidae	1		3
Ephemeroptera			
Caenis			
Isonychia			
Stenonema	1	1	3
Heptagenia			
Pentagenia			
Tricorythodes			
Hexagenia	1		
Diptera			
Chironomid pupae			
Chironomid larvae	65	90	95
Polypedium l.			
Simuliidae			
Plecoptera			
Alloperla			
Paragentina		4	1
Acroneuria			
Crustacea			
Asellus	6	7	5
Hyalella		1	
Daphnia			2

*Note:

Substrate #1 150' downstream from outflow

Substrate #2 140' downstream from outflow

Substrate #3 130' downstream from outflow

Source: Hey and Baldwin 18/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 8 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
Special Winter Sites
February 15 - March 15, 1974

Taxonomic group	*Substrate Numbers #1	#2	#3	#4	#5	#6
Insecta						
Trichoptera						
Hydropsychidae	14	5	13	4	1	1
Rhyacophilidae		1				
Ephemeroptera						
Caenis						
Isonychia						
Stenonema	2	1	2			
Heptagenia						
Pentagenia						
Tricorythodes						
Diptera						
Chironomid pupae	18	23	18	3	4	1
Chironomid larvae	130	200	125	102	42	52
Polypedium l.						
Simuliidae		1				
Plecoptera						
Alloperla						
Paragentina	2	4	4	3	2	1
Acroneuria						2
Crustacea						
Asellus	1		1	3		2
Hyalella	1					
Daphnia						
Decapoda						
Gastropoda	1		1			
Nematoda	1	1		1		
Turbellaria						
Planaria		2				

*Note:

Substrate #1 150' downstream from outflow
Substrate #2 140' downstream from outflow
Substrate #3 130' downstream from outflow
Substrate #4 270' upstream from inflow
Substrate #5 280' upstream from inflow
Substrate #6 290' upstream from inflow

One Stone Catfish (6 cm) was found in substrate #3

Source: Hey and Baldwin 18/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
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TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
Special Winter Sites
March 15 - April 15, 1974

*Substrate Numbers

Taxonomic group	#1	#2	#3	#4	#6
Insecta					
Trichoptera					
Hydropsychidae	50	35	19	8	35
Rhyacophilidae	3	4	1	2	
Ephemeroptera					
Stenonema	4	1			1
Hexagenia	2	1			
Diptera					
Chironomid pupae	6	2	3	1	2
Chironomid larvae	45	30	18	11	13
Polypedium 1					
Simuliidae	3		1		1
Plecoptera					
Alloperla					
Paragentina	14	4	5	2	2
Acroneuria					
Crustacea					
Asellus	2	5		2	
Hyalelia					
Daphnia	1				
Decapoda					1
Gastropoda			1		
Pelecypoda					
Sphaerium	1				
Nematoda	4	4	1		
Turbellaria					
Planaria	1	4			
Stone Catfish (Noturus flavus)			1		

*Note:

Substrate #1 150' downstream from outflow
Substrate #2 140' downstream from outflow
Substrate #3 130' downstream from outflow
Substrate #4 270' upstream from inflow
Substrate #6 290' upstream from inflow

Source: Hey and Baldwin 18/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1973
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TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
April 15 - May 15, 1974

Substrate Numbers	1	2	3	4	5	6	7	8
Insecta								
Trichoptera								
Hydropsychidae	45	25	13	16	11	24	45	27
Rhyacophilidae	3	2	3	1	3	1	3	2
Leptoceridae		1					1	2
Ephemeroptera								
Caenis			1			1	1	5
Stenonema		6	2	2	1	3		1
Diptera								
Chironomid pupae	1	4	11		10	13	2	4
Chironomid larvae	32	100	80	75	120	100	110	150
Simuliidae	15	55	23	70	13	55	11	7
Anthomyiidae				1				
Unknown			1					
Plecoptera								
Paragentina	2	3	2	3	2	4	6	8
Odonata								
Zygoptera		2	1		2	1		2
Crustacea								
Asellus				1				
Gastropoda								
Nematoda		1	2	2	5	2		

Substrate Numbers	9	10	11	12	13	14	15	16
Insecta								
Trichoptera								
Hydropsychidae	23	15	6	18	3	8	43	28
Rhyacophilidae	2	2		1		1	8	3
Leptoceridae	1			1			1	3
Ephemeroptera								
Caenis	2	1	1		1	1	5	
Stenonema	1	1		3	1	11	2	6
Diptera								
Chironomid pupae	1	5	9	6	4	8	28	27
Chironomid larvae	125	200	210	180	60	200	220	200
Simuliidae	2	6	24	12	13	6	20	7
Anthomyiidae								1
Unknown								
Plecoptera								
Paragentina	6		1	2	5	6	22	28
Odonata								
Zygoptera								2
Crustacea								
Asellus		1			10	16	25	3
Gastropoda	1							
Nematoda	1	2	6	8	1	4	5	8

Source: Hey and Baldwin 13/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
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ARTIFICIAL BOTTOM SUBSTRATES
April 15 - May 15, 1974
(continued)

Substrate Numbers	17	18	19	20	21	22	23	24
Insecta								
Trichoptera								
Hydropsychidae	42	38				27	31	38
Rhyacophilidae	7	16				7	6	1
Leptoceridae	4						2	1
Ephemeroptera								
Caenis								
Stenonema	6	11				4	1	3
Diptera								
Chironomid pupae	16	34				6		4
Chironomid larvae	272	720	17	10		65	80	76
· Simuliidae	90	190			1	7	7	13
Anthomyiidae								
Unknown								
Plecoptera								
Paragentina	22	17	1			15	26	15
Odonata								
Zygoptera								
Crustacea								
Asellus		1	4	3				
Hyalella							1	
Gastropoda		1	1					
Turbellaria								
Planaria					1			
Nematoda	3	9	1				1	1

Source: Hey and Baldwin [18/]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4
ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
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(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
May 15 - June 14, 1974

Substrate Number

	1	2	3	4	5	6	7	8	9	10	11	12
Insecta												
Trichoptera												
Hydropsychidae	38	15	13	8	2	3	33	3	3	6	6	12
Rhyacophilidae	14	26	14	10	5	6	15	8	7	28	8	14
Leptoceridae						1	2		1		1	
Unknown pupae			2	2			10	3	6	2		5
Ephemeroptera												
Caenis	1	2	1		1	2		1	5	5	1	
Isonychia	15	6	12	6			25	7	2	8	8	13
Stenonema	7	3	7		7	4	1	8	10		31	3
Ephoron	33	6	28	7	6	2	4	4	2		8	2
Diptera												
Chironomid pupae	12	8	21	4	2	8	4	2	13	4	2	1
Chironomid larvae	150	175	245	70	25	20	45	28	31	20	30	25
Simuliidae						1				1		
Anthomyiidae		1										
Tipulidae				1								
Tabanidae				1								
Unknown		5										
Plecoptera												
Paragentina	9	13	13	9		1	38	3	10	13	8	14
Odonata												
Zygoptera						2						
Crustacea												
Asellus	4	17	15	4	27	12	1	2	6	2	7	2
Decapoda			2		1	3		8	3	2	1	1
Gastropoda			2			4						
Pelecypoda												
Hirudinea				1								
Nematoda							1					
Turbellaria												
Planaria		2				1						
Hydrazoa				100	100	50			50			

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 13 OF 35)

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(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
May 15 - June 14, 1974

Substrate Number	13	14	15	16	17	18	19	20	21	22	23	24*
Insecta												
Trichoptera												
Hydropsychidae	2	3	9	3	11	13				6	4	
Rhyacophilidae	8	17	7	33	16	19				23	4	
Leptoceridae	1		1									
Unknown Pupae			3			7				2	1	
Ephemeroptera												
Caenis									1	1		
Isonychia	1	4	22	2	10	3			1	6	6	
Stenonema			4	9	5						3	
Ephoron			6			3				8	2	
Diptera												
Chironomid pupae	2		2	2		1			1			
Chironomid larvae	15	1	13	3	1	10		13	85	18	1	
Simuliidae												
Anthomyiidae												
Tipulidae												
Tabanidae												
Unknown												
Plecoptera												
Paragentina	3		8	7	4					13	17	
Odonata												
Zygoptera	2									1		
Crustacea												
Asellus	105	75	18	18	5	9	140	185	200	1	1	
Decapoda				1	5		2	4	2		1	
Gastropoda												
Pelecypoda						1						
Hirudinea												
Nematoda			1						3			
Turbellaria												
Planaria				5		2	35	100	50			
Hydrazoa		75										

*Substrate number 24 was missing from the river on the June collection date.

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 14 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
June 15 - July 18, 1974

Substrate Number	1*	2	3	4	5	6	7	8	9	10	11	12
Insecta												
Trichoptera												
Hydropsychidae		125	175	45	38	65	225	53	28	350	18	25
Leptoceridae				1	1			1	2			1
Rhyacophilidae		47	40	8	30	35	20	5	5	20	8	8
Unidentified pupae		5	3	2	3	3	8	2		8	6	5
Ephemeroptera												
Caenis		73	88	58	37	40	80	15	2	40	35	20
Ephoron		2			1		1		1			
Isonychia		2	1	1	1	2	3	2	1	46	1	
Stenonema											2	1
Tricorythodes												
Diptera												
Anthomyiidae					2		1	1	2			
Chironomid larvae		70	75	44	86	90	175	90	54	160	16	23
Chironomid pupae				2	1	4	1	4	4	6	1	1
Simuliidae		2	6	2		1	6	1		5	1	1
Unidentified												
Plecoptera												
Paragentina							1					
Neuoptera												
Sialis						1						
Crustacea												
Decapoda				1		1		2	1		2	
Isopoda												
Asellus		3	2	4	3	2	6	5	2	10	10	1
Gastropoda				1	2	1	2	23	16		2	
Pelecypoda				1		1	10	1	4		1	1
Hirudinea		1	1						1	1	11	
Planaria											2	

* Substrate number 1 was not present when substrates were pulled on July 18..

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 15 OF 35)

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TABLE
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(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
June 15 - July 18, 1974

Substrate Number	13	14	15	16	17	18	19	20	21	22	23	24
Insecta												
Trichoptera												
Hydropsychidae	34	20	25	10	63	28				10	275	550
Leptoceridae		1		1		1						
Rhyacophilidae	16	20	16	24	26	32	3	2	1	16	10	6
Unidentified pupae		1	2	2	13	5				1	1	
Ephemeroptera												
Caenis	18	36	21	14	62	45	1	4	2	50	200	28
Ephoron						2					1	
Isonychia		2	1		10	1			2	1	135	60
Stenonema		4	3	2	1	3	1		1			1
Tricorythodes			3	2		5		1		1	3	
Diptera												
Anthomyiidae			4		1	1						1
Chironomid larvae	44	40	20	22	40	39	2	12	10	22	16	19
Chironomid pupae			3	10	1	5				4	2	2
Simuliidae		4				1					4	6
Unidentified		1	2	1								
Plecoptera												
Paragentina			2		2						1	
Neuoptera												
Sialis												
Crustacea												
Decapoda		1		2	1		4		11	2		
Isopoda												
Asellus	35	210	100	17	3	14	36	8	91	1		
Gastropoda				1		1						
Pelecypoda					2							
Hirudinea		1		2				1				
Planaria	1	1	3	4	1	4		4	12			

Source : Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 16 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
July 18 - August 15, 1974

Substrate Number	1	2	3	4	5	6	7	8	9	10	11	12
Insecta												
Coleoptera												
Haliplidae larvae	1											
Diptera												
Anthomyiidae	1	1							1			
Chironomid larvae	30	9	30	8	25	33	9	15	52	27	14	8
Chironomid pupae	2	1	5	2	7	6		2	3	1		
Simuliidae		1							2	1	3	4
Unknown									5			
Ephemeroptera												
Caenis	18	8	10	8	17	23	12	20	27	28	6	4
Ephoron												
Isonychia	2	18	29				4	7	8	50	3	2
Stenonema	3	9	5	2	2	5			5		1	1
Tricorythodes		1			1			1	12			
Neuoptera												
Sialis	1											
Odonata												
Anisoptera						1						
Zygoptera					1							
Plecoptera												
Paragentina												
Trichoptera												
Hydropsychidae	30	140	45	50	8	12	45	42	66	70	35	14
Leptoceridae								1				
Rhyacophilidae	27	18	11	20	5	14	15	8	7	6	8	8
Unknown pupae	5	9	6	9	3	4	4	2	4	28	2	5
Crustacea												
Asellus			1	5	4	14	2	17	6		8	
Decapoda												
Hirudinea							1					
Hydrozoa						1						
Gastropoda		1			1			1		1	1	
Nematoda					1	1						
Pelecypoda		1		1	3		9	2	1		1	
Planaria		13	51	30	25	3	28	44	55	23	10	4

Source: Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 17 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
July 18 - August 15, 1974

Substrate Number	13	14	*15	16	17	18	19	20	21	22	23	24
Insecta												
Coleoptera												
Haliplidae larvae												
Diptera												
Anthomyiidae					1							
Chironomid larvae	15	11		23	55	23	24	6	13	37	30	30
Chironomid pupae	4	4		3	3					3	4	
Simuliidae	1										1	2
Unknown		1										
Ephemeroptera												
Caenis	8	4		19	8	4	7	3	15	7	11	12
Ephoron	1											
Isonychia	30	4		6	25	2					145	180
Stenonema		3		4	7	1	3	2		2		
Tricorythodes						1			1	1	1	
Neuoptera												
Sialis												
Odonata												
Anisoptera		1			3		1					1
Zygoptera		1						1		1		
Plecoptera												
Paragentina												1
Trichoptera												
Hydropsychidae	25	10		3	160	55	3			9	40	245
Leptoceridae									1		1	
Rhyacophilidae	8	2		5	17	6	2			4	7	3
Unknown pupae	10			2	9	6				3	4	45
Crustacea												
Asellus	14	68		35	2	8	38	41	136	1		
Decapoda				1		1	6	6				
Hirudinea						1		1	1			
Hydrozoa										8		
Gastropoda		1		3								
Nematoda												
Pelecypoda		1		4					5		2	
Planaria	2	3		13	50	2	66	40	78	6		

*Substrate 15 was missing when samples were collected August 15.

Source: Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 18 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES

August 15 - September 18, 1974

Substrate number

	1	2	3	4	5	6	7	*8	9	10	11	12
Insecta												
Diptera												
Anthomyiidae	4			1	1				1	1		
Chironomid larvae	24	24		7	55	28	20		15	35	35	9
Chironomid pupae	1	8	2		2		6		4	5	4	1
Simuliidae		1	2	1			2				1	
Unknown	1											
Ephemeroptera												
Caenis	2	2		3	1	1	3		3		2	
Ephoron												
Isonychia	2	2				1			5	1	2	1
Stenonema	2	1	1								1	2
Tricorythodes	4	1	1			5				1		
Odonata												
Anisoptera	1					1						
Zygoptera	1								1			1
Trichoptera												
Hydropsychidae	48	90	65	80	67	45	>1000		275	32	155	45
Leptoceridae						1	4					
Rhyacophilidae	6	9	2	6	11	31	6		1	5	13	10
Unknown pupae		9	3		5	3	31		11	8	2	12
Crustacea												
Decapoda												
Isopoda												
Asellus	3	2	1	1	3	8	2		3	5	6	1
Gastropoda	1				2	5	2			1		
Hirudinea		1		1	1				1			
Hydrozoa							3					3
Nematoda	1											
Pelecypoda	1	2		2		29	12		5	1	1	11
Planaria	13	70	100	23	16	20	45		35	125	6	22

* Missing

Source: Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 19 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
August 15 - September 18, 1974

Substrate number	13	14	*15	16	17	18	19	20	21	22	23	24
Insecta												
Diptera												
Anthomyiidae				2		1						
Chironomid larvae	22	30		18	30	13	2	17	7	22	15	18
Chironomid pupae	5	3			5	1	1			8	7	
Simuliidae	1				1						1	
Unknown												
Ephemeroptera												
Caenis	6	4		4	1			1			5	
Ephoron									1			
Isonychia	3	4			2	1				18	3	3
Stenonema												1
Tricorythodes	1			1		3	1					1
Odonata												
Anisoptera	1					1						
Zygoptera				1			6	9	10			
Trichoptera												
Hydropsychidae	145	145		53	130	50				300	275	90
Leptoceridae												
Rhyacophilidae	18	30		11	55	43	3			11	5	6
Unknown pupae	4			2	6	6				29	8	1
Crustacea												
Decapoda						1	4		1			
Isopoda												
Asellus	14	20		11	4	7	15	5	28	3	1	1
Gastropoda												
Hirudinea							1		2			
Hydrozoa	5	2			6	2			4			3
Nematoda				1						1		
Pelecypoda	1			4		6						
Planaria	33	20		11	90	14	5	4	2	12	3	1

*Missing

Source: Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 20 OF 35)

DATE:
SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES

September 18 - October 16, 1974

Substrate Number	1	2	3	4	5	6	7	8	9	10	11	12
Insecta												
Diptera												
Anthomyiidae												
Chironomid larvae	14	16	14	21	8	15	5	7	25	24	15	7
Chironomid pupae	5	1			1		1	1	1		1	1
Simuliidae		2		2		2	1	1				
Ephemeroptera												
Caenis		2							1		2	
Hexagenia												
Isonychia	1		1				2	7	5	2		
Stenonema	6	6				4	6	2	12	1		2
Tricorythodes			1									
Odonata												
Anisoptera					1							
Zygoptera	2			1		1		2				
Trichoptera												
Hydropsychidae	25	85	30	40	6	25	10	20	15	8	60	20
Leptoceridae			2									
Rhyacophilidae	5	18	10	15	4	5	4			11	15	11
Unknown pupae	6	4	1	5					3	4	9	
Crustacea												
Decapoda												
Isopoda												
Asellus	10	9	8	3	14	10	4	2	2	6	5	1
Gastropoda	1	3			1			4		2		
Hydrozoa	12	35	25			6	14		20			8
Nematoda						2				2	3	1
Pelecypoda	2			1	7	8			1	3	8	
Planaria	7	32	110	13	4	5	2	3	23	100	28	1
Fish										1*		1**

* 7 cm Stonecat
** 4 cm Stonecat

Source: Hey and Baldwin 17/

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 21 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
September 18 - October 16, 1974

Substrate Number	13	14	15	16	17	18	19	20	21	22	23	*24
Insecta												
Diptera												
Anthomyiidae				2	15		1					
Chironomid larvae	15	20	15	10	4	3	4	14	4	15	17	
Chironomid pupae			2	2	1							
Simuliidae		1				3	2			1		
Ephemeroptera												
Caenis												
Hexagenia												
Isonychia					4	1				1	15	
Stenonema	1		2	1	5	3		2			1	
Tricorythodes												
Odonata												
Anisoptera								1	1			
Zygoptera	1	1					11	10	2			
Trichoptera												
Hydropsychidae	50	45	10	25	40	30	2	3		23	175	
Leptoceridae				1								
Rhyacophilidae	15	18	8	40	30	15	10	1		28	9	
Unknown pupae					2						1	
Crustacea												
Decapoda							4	1		1		
Isopoda												
Asellus	7	40	125	14	18	13	165	28	13	3	1	
Gastropoda												
Hydrozoa	3	5	1	13	45	13		5		100	100	
Nematoda			1							1		
Pelecypoda		3		7	1							
Planaria	10	13	1	40	37	16	8	2		3		

* Were not in river when sampled October 16.

Source: Rey and Baldwin [17]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 22 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
October 16 - November 19, 1974

Substrate Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Insecta														
Diptera														
Anthomyiidae														
Chironomid larvae		11	18	8	4	4	18	2	11	4	10	13	2	5
Chironomid pupae				1										
Simuliidae													2	
Ephemeroptera														
Isonychia			1			1	7			5				3
Stenonema	3	12	14	3	8	10	20	8	13	13	16	4	1	4
Tricorythodes						1								
Hemiptera														
Corixidae														
Odonata														
Anisoptera								1	1					
Zygoptera		1	1	2	1				1				1	
Plecoptera														
Paragentina	2	2	7	1	1	3		2	4		1	1	2	1
Trichoptera														
Hydropsychidae	13	20	20	50	3	50	5	4	7	30	14	2	14	32
Leptoceridae														
Rhyacophilidae	15	4	12	7	3	20	7	1	5	13	3	2	3	4
Crustacea														
Decapoda								1	1					
Isopoda														
Asellus	45	35	16	9	40	30	5	8	7	30	35	9	95	350
Amphipoda														
Hyalella														
Gastropoda	1	1	1	1	5			2	1	4	3		2	1
Hydrazoa	50	30	10		10	30	5		5	10	10	5		8
Hirudinea											1			1
Nematoda							2							
Pelecypoda	2		1		4	3	1		2	3	5			
Planaria	6	28	6		3	6	3	1	10	19	20	1	4	12
Stonecatfish*				1	2									

* #4, 6 cm. #5, both 6 cm.

Source: Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 23 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
October 16 - November 19, 1974

Substrate Number	15	16	17	18	19	20	21	22
Insecta								
Diptera								
Anthomyiidae						1		
Chironomid larvae	5	4	2	3	3	12		10
Chironomid pupae								
Simuliidae	1	1						
Ephemeroptera								
Isonychia			1	4				1
Stenonema	3	9	10	7	10	1		2
Tricorythodes			1					
Hemiptera								
Corixidae					2	2		
Odonata								
Anisoptera						1		
Zygoptera		1			13	23		3
Plecoptera								
Paragentina	2	7	3	5		1		5
Trichoptera								
Hydropsychidae	5	22	35	125	3	1		45
Leptoceridae		1				1		
Rhyacophilidae	2	28	60	35	1	4		14
Crustacea								
Decapoda								
Isopoda								
Asellus	225	75	35	20	400	185		23
Amphipoda								
Hyalella		2			8	2		1
Gastropoda	2				1			
	80	80	>100					>250
Hydrazoa								
Hirudinea								
Nematoda								
Pelecypoda		3	1					1
Planaria	1	18	45	13	10	1		

Source: Hey and Baldwin[17/]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 24 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
Winter Sites
November 19 - December 17, 1974

Substrate Number	7	8	9	11	12
Insecta					
Diptera					
Chironomid larvae	9	13	4	1	8
Ephemeroptera					
Stenonema	25	55	18	2	
Odonata					
Zygoptera	1	3	2	1	
Plecoptera					
Paragentina	14	15	14	2	2
Trichoptera					
Hydropsychidae	70	80	34	15	300
Rhyacophilidae	5	10	4	3	10
Crustacea					
Decapoda		1			
Isopoda					
Asellus	15	40	8	2	15
Amphipoda					
Hyalella			1		
Gastropoda	3	3			
Nematoda		1			
Pelecypoda			2	1	
Planaria	33	40	5		
Stonecatfish*					1

* 6.5 cm

Substrate location:

#7,8,9 just downstream from new Neal III outflow

#10,11,12 between Neal II intake and Sample Site #6

Source: Hey and Baldwin[17]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 25 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES

Winter Sites

December 17, 1974 - January 21, 1975

Substrate Number	7	8	9
Insecta			
Diptera			
Chironomid larvae	3	5	5
Ephemeroptera			
Stenonema			1
Odonata			
Anisoptera			1
Plecoptera			
Paragentina	1	1	1
Trichoptera			
Hydropsychidae	120	88	104
Rhyacophilidae	4		4
Crustacea			
Decapoda		1	
Isopoda			
Asellus	1	1	1
Gastropoda		2	

Table 42

January 21, 1975 - February 24, 1975

Substrate Numbers	7	8	9	10	11
Insecta					
Diptera					
Chironomid larvae	38	35	18		nothing
Ephemeroptera					
Stenonema	2				
Plecoptera					
Paragentina	1	4			
Trichoptera					
Hydropsychidae	17	16	27	3	
Rhyacophilidae	2	1	1		
Crustacea					
Isopoda					
Asellus	2	8	7	1	
Nematoda			2	1	

Substrate location:

#7,8,9 just downstream from New Neal III Outflow

#10,11,12 between Neal II intake and sampling site #6

* due to winter ice conditions these substrates have only been submerged a very short time, less than 1 month. #12 was not present February 24.

Source: Hey and Baldwin 17/

envirosphere company

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 26 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
May 22 - June 30, 1975

Reproduced from best available copy.

Substrate Number

	1	2	3	4	5	6	7
Insecta							
Coleoptera							
Haliplidae larvae					1		
Diptera							
Anchomyiidae		1			1		2
Chironomid larvae	23	35	24	23	28	18	23
Chironomid pupae	1	5	4	1	2	3	6
Simuliidae	2	4	1	3	21	2	7
Unknown			1				
Ephemeroptera							
Caenis	1	5	4	1	1	3	3
Ephoron	3	7	8	8	23		6
Isonychia	1				4	1	21
Stenonema	6	2	7	4	5	5	12
Tricorythodes			2			3	
Odonata							
Anisoptera							
Zygoptera							2
Plecoptera							
Paragentina					2		2
Trichoptera							
Hydropsychidae	6	25	1	6	36	3	15
Leptoceridae							
Rhyacophilidae	18	28	15	20	24	18	20
Unknown pupae	3	11	3	3	4	1	23
Crustacea							
Decapoda			2			4	2
Isopoda							
Asellus	25	31	45	21	35	28	19
Amphipoda							
Hyalella							
Gastropoda		1					
Hirudinea			3				
Hydrozoa							
Nematoda						1	
Pelecypoda		1					
Planaria				5			

Source: Hay and Baldwin [17]

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 27 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
May 22-June 30, 1975

Substrate Number	8	9	10	12	13	14	15
Insecta							
Coleoptera							
Halipidae larvae							
Diptera							
Anthomyiidae			1	1	6		1
Chironomid larvae	22	28	14	40	32	11	25
Chironomid pupae		2	1		2	3	1
Simuliidae			6	4			2
Unknown							
Ephemeroptera							
Caenis	4	3		6	4		1
Ephoron	2	5	9	4			1
Isonychia		5	4		5		1
Stenonema	3	5	10	2	2	3	4
Tricorythodes	2	2			1		
Odonata							
Anisoptera	1	1	1				1
Zygoptera							
Plecoptera							
Paragentina	2	8	1				
Trichoptera							
Hydropsychidae	5	7	31	28	19		23
Leptoceridae					1	1	1
Rhyacophilidae	40	20	40	33	50	20	17
Unknown pupae	3	18	3		5	1	4
Crustacea							
Decopoda		2	1		2	1	
Isopoda							
Asellus	10	15	25	55	105	140	45
Amphipoda							
Hyalella			1			1	
Gastropoda							
Hirudinea		1	1	1		1	
Hydrozoa		10				160	
Nematoda		1		1		2	
Pelecypoda	3						
Planaria		1	1	2			

Source: Hey and Baldwin [17]/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 28 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICAL BOTTOM SUBSTRATES
June 30 - July 28, 1975

Substrate Number	1	2	3	4	5	6	7
Insecta							
Diptera							
Anthomyiidae			1				
Chironomid larvae	4	17	13	14	10	17	10
Chironomid pupae	2	1			3	1	
Simuliidae	1						
Unknown							
Ephemeroptera							
Caenis	7	7	1	5		1	15
Ephoron		1					
Isonychia							88
Stenonema	1		1	3	6		
Tricorythodes	1		1		3		3
Plecoptera							
Paragentina							
Trichoptera							
Hydropsychidae	12	25	12	24	14	2	110
Leptoceridae						1	
Rhyacophilidae	28	17	17	25	5	33	14
Unknown pupae	1	2	2	10	15		4
Crustacea							
Decopoda			1				
Isopoda							
Asellus	5	11	18	10	8	3	
Gastropoda	2	2					
Hirudinea	1				1		
Nematoda							
Pelecypoda						2	
Planaria				1	3		
Fish (Stonecat)							

Source: Hey and Baldwin 17/

envirosphere company

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 29 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
June 30 - July 28, 1975

Substrate Number	8	9	10	11	12	13	15
Insecta							
Diptera							
Anthomyiidae	1						
Chironomid larvae	8	17	1	12	19	18	10
Chironomid pupae		4					
Simuliidae	1	1			2		
Unknown				1			
Ephemeroptera							
Caenis	2	10		7	2	4	
Ephoron	3	2			1		
Isonychia	22	300			5	4	
Stenonema	5	7			8		1
Tricorythodes	1				1		
Plecoptera							
Paragentina	3						
Trichoptera							
Hydropsychidae	155	150		2	12	26	4
Leptoceridae		1					
Rhyacophilidae	21	30		12	22	9	8
Unknown pupae	12	25	3		5	6	
Crustacea							
Decopoda		1			1		
Isopoda							
Asellus	2	3	2	3	11	9	4
Gastropoda							
Hirudinea	1					3	
Nematoda					1		
Pelecypoda							
Planaria		3			1	1	
Fish (Stonecat)					1		

Source :- Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 30 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
July 28 - August 28, 1975

Substrate Number

	1	2	3	5	6	7	9	10	11	12	13	14	15
Insecta													
Diptera													
[illegible]omyiidae	2	1				2		1				1	1
Chironomid larvae	56	15	24	15	16	9	12	23	21	16	39	12	20
Chironomid pupae			3	2	3				1	1	6		
Simuliidae	2	3		5			3	1	6	1	1		
Unknown								1	1				
Ephemeroptera													
Caenis	18	50	23		16	7	2	9	6	5	10	6	12
Isonychia	50	40	18	45	1	42	115	11	15	11	34		
Stenonema	12	2	12	62	35	16	11	3	2		51	9	11
Tricorythodes	2	1	2	2	1	4	1	1	3	1		2	
Odonata													
Anisoptera	2	1		2	1					1			3
Zygoptera			3	1	3		1	4		1		2	1
Trichoptera													
Hydropsychidae	120	65	65	23	6	29	17	15	11	25	58	1	
Leptoceridae	2		1									2	2
Rhyacophilidae	30	30	50	45	4	1	1	7	18	6	70	8	6
Unknown pupae		2				5	1	1		1	2		
Crustacea													
Decapoda					1		3				1		
Isopoda													
Asellus	8	10	18	13	7	8		22	9	17	3	49	60
Gastropods					1			2	1	1			
Hirudinea						1		3			2		
Hydrazoa													1
Nematoda												1	
Pelecypoda					2					1			
Planaria	2	1	2	2		1	1	1		1		4	
Stonecatfish										1			

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 31 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
August 28-September 28, 1975

Substrate Number	1	2	3	4	5	7	10	11	12	13	14	15
Insecta												
Diptera												
Chironomid larvae	23	72	22	21	36	42	23	10	19	28	5	42
Chironomid pupae	6	12	2	1	3	3	3	2		1		
Simuliidae	2	8	2	5	7	5	4	4	3	1		
Ephemeroptera												
Caenis	6	4		5	12	1	1	2	1	6	1	8
Hexagenia												
Isonychia	4	20	32	10	22	12	19	8	22	11	6	20
Stenonema	1	12	3	5	2	1	1	3	14	8	5	6
Tricorythodes	1		1	1	1		1				1	
Odonata												
Anisoptera	1						1	2	2	1	3	
Zygoptera	1		4	2	7		1	1		1	2	2
Trichoptera												
Hydropsychidae	19	192	3		2	5	4	4	4	5		10
Rhyacophilidae	46	232	15	15	12	3	22	8	13	62	9	138
Unknown pupae	1											
Crustacea												
Decapoda										2		
Isopoda												
Asellus	10	212	46	25	15	1	26	27	15	46	24	104
Amphipoda												
Hyalella												8
Gastropoda	2	4	8	2	1		3					2
Hydrozoa			89	59	122	3				125		212
Pelecypoda			1	6	15							
Planaria		12	1	3	6	2	1	2	1	2		12

Source : Hey and Baldwin 17/

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 32 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
September 28-October 30,1975

Substrate Number	1	2	5	6	7	8	10	11	12	13	14	15
Insecta												
Diptera												
Chironomid larvae	17	38	36	58	14	55	8	21	16	7	4	10
Chironomid pupae				1	4	8			4	1		
Simuliidae		6	2		4	5		2	2			
Ephemeroptera												
Caenis	1			4							4	6
Isonychia		6	6		3	4			10	1		2
Stenonema		18	28	28	6	8	2	2	30	4	16	4
Odonata												
Anisoptera							2		2			8
Zygoptera		8	2		1		2		2		4	4
Trichoptera												
Hydropsychidae	61	10	8	6	5	5		8	4	102		6
Rhyacophilidae	43	44	9	30	9	8	8	16	36	60	8	50
Crustacea												
Decopoda		1										
Isopoda												
Asellus	26	74	34	20	4	6	48	64	34	49	188	166
Amphipoda												
Hyalella			2		3			2	2	4	2	4
Gastropoda				4			4		2		2	
Hirudinea											1	
Hydrozoa	76	130	72	620	16	36						112
Pelecypoda		2		30			2	1		1		8
Planaria	1	2	6	6	4	3		.4			2	

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 33 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
October 30 - November 18, 1975

Substrate Number	1	2	5	6	7	8	8*	10	11	12	13	14
Insecta												
Diptera												
Chironomid larvae	24	8	15	32	6	18	14	6	6	5	12	6
Chironomid pupae				2	1		2					
Simuliidae					1			6	2			
Ephemeroptera												
Caenis			3			6	4			5	2	
Isonychia	4		3	2	3	10	2	3	4	10	6	2
Stenonema	16	14	18	20	3	48	64	45	10	45	28	24
Odonata												
Anisoptera				2								
Zygoptera		4			1		2	3			2	4
Plecoptera												
Paragentina	2			2		18	16	18		10	6	2
Trichoptera												
Hydropsychidae	44	2	21	12	4	14	22	3	10	35	21	4
Rhyacophilidae	56	6	24	40	1	8	22	24	20	15	56	2
Crustacea												
Decapoda			3	1		2					2	
Isopoda												
Asellus	240	194	63	38	12	34	22	54	146	35	108	238
Amphipoda												
Hyalella				2	3	8	4	3		5		
Gastropoda	8					2		18	2			
Hirudinea							2		2			
Hydrozoa		95		187			330	30		450	130	136
Pelecypoda				12		2					2	
Planaria		2		4	8	16	24	9	18		4	

*8 - recovered substrate which was lost in mid-August 1975

Source : Hey and Baldwin 17/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 34 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

ARTIFICIAL BOTTOM SUBSTRATES
October 30 - November 18, 1975

Substrate Number	1	2	5	6	7	8	8*	10	11	12	13	14
Insecta												
Diptera												
Chironomid larvae	24	8	15	32	6	18	14	6	6	5	12	6
Chironomid pupae				2	1		2					
Simuliidae					1			6	2			
Ephemeroptera												
Caenis			3			6	4			5	2	
Isonychia	4		3	2	3	10	2	3	4	10	6	2
Stenonema	16	14	18	20	3	48	64	45	10	45	23	24
Odonata												
Anisoptera				2								
Zygoptera		4			1		2	3			2	4
Plecoptera												
Paragentina	2			2		18	16	18		10	6	2
Trichoptera												
Hydropsychidae	44	2	21	12	4	14	22	3	10	35	21	4
Rhyacophilidae	56	6	24	40	1	8	22	24	20	15	56	2
Crustacea												
Decapoda			3	1		2					2	
Isopoda												
Asellus	240	194	63	38	12	34	22	54	146	35	108	238
Amphipoda												
Hyalella				2	3	8	4	3		5		
Gastropoda	8					2		18	2			
Hirudinea							2		2			
Hydrozoa		95		187			330	30		450	130	136
Pelecypoda				12		2					2	
Planaria		2		4	8	16	24	9	18		4	

*8 - recovered substrate which was lost in mid-August 1975

Source : Hey and Baldwin [17/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

ARTIFICAL SUBSTRATE DATA
APRIL 1973 - NOVEMBER 1975
(SHEET 35 OF 35)

DATE: SCALE:

TABLE
A-III-C-3
(Cont'd)

TABLE A-III-C-4

SUMMARY OF MISSOURI RIVER BACKWATERS SEINING DATA

1971 - 1975

	(200 ft of sand bar, 250 ft of backwaters, and 200 ft of the channel* behind the trail dyke were seined		(600 ft of backwaters and 225 ft of the small channel** were seined)		(100 ft of shallow channel,*** 250 ft of sand bar and 425 ft of backwaters were seined)	
	Summer 1971		Fall 1971		Spring 1972	
Species	Total Count	Percent Young of Year	Total Count	Percent Young of Year	Total Count	Percent Young of Year
Gizzard Shad	218	100	277	100	36	90
Carp	5	0	1	0	23	82
Bluegill			4	0	1	0
Crappie	3	0	62	100	3	33
White bass	14	0	1	0		
Carpsucker	216	99	11	0	73	78
Largemouth bass			8	100	3	100
Sauger	25	100	11	92	4	67
Walleye			5			
Johnny darter			3			
Pumpkinseed			4			
Plains flathead chub					2	
Black bullhead					5	
Shortnose gar					2	
Channel catfish					1	
Goldeye					1	

Source: Baldwin and Hey 13/ and Hey and Baldwin 14/
Collections were made with a 30' by 6' bag seine with a 4' by 4' bag

Channels were located at *Site A, **Site A and ***below Site F (Figure III-C-16)

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SUMMARY OF MISSOURI RIVER
BACKWATERS SEINING DATA, 1971 - 1975
(SHEET 1 OF 7)

DATE: SCALE:

TABLE
A-III-C-4

	(500 ft of sand bar, 750 ft of backwaters, and 100 ft of narrow channel* were seined)		(800 ft of backwaters were seined)			
	Summer 1972		Fall 1972		Spring 1973	
Species	Total Count	Percent Young of Year	Total Count	Percent Young of Year	Total Count	Percent Young of Year
Bluegill	2	100	9	100	Low river levels. Precluded seining in backwaters.	
Carpsucker	52	87	23	60		
Crappie	258	100	336	98		
Carp	6	100	5	60		
Freshwater drum	18	89				
Gizzard shad	174	99	3	100		
Goldeye	3	100	1	0		
Largemouth bass	1	100	6	100		
Northern pike			1	0		
Sauger	12	100	4	100		
Walleye			1	0		
White bass	20	100	20	100		
Yellow perch	3	0	1	100		

Source: Baldwin and Hey [13/] and Hey and Baldwin [14/]

*Channel was located at Site J (Figure III-C-16)

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SUMMARY OF MISSOURI RIVER
BACKWATERS SEINING DATA, 1971 - 1975
(SHEET 2 OF 7)

DATE: SCALE:

TABLE
A-III-C-4
(Cont'd)

BAG SEINING DATA

August 1973 (a total of 825 ft were seined.
625 ft were in backwaters
200 ft were along sandbars)

Species	No.	Percent Abundance	Percent Young of Year
Bluegill			
Carp	6	.5	50
Carpsucker	436	36.6	96
Channel Catfish	1	.1	100
Crappie	94	7.9	96
Freshwater Drum	123	10.3	99
Gizzard Shad	414	34.8	100
Goldeye			
Largemouth Bass			
Northern Pike	1	.1	0
Redhorse	11	.9	100
Sauger	9	.8	78
Shortnose Gar	7	.6	0
Walleye	1	.1	100
White Bass	88	7.4	100
Yellow Perch			
Total	1191		

Source: Baldwin and Hey[18/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SUMMARY OF MISSOURI RIVER
BACKWATERS SEINING DATA, 1971 - 1975
(SHEET 3 OF 7)

DATE: SCALE:

TABLE
A-III-C-4
(Cont'd)

October 1973 (a total of 675 ft were seined.
550 ft were in backwaters
125 ft were along shorelines)

Species	No.	Percent Abundance	Percent Young of Year
Bluegill	18	5.1	100
Carp	3	.8	33
Carpsucker	89	25.1	99
Crappie	41	11.6	90
Freshwater Drum	9	2.5	100
Gizzard Shad	88	24.8	100
Goldeye			
Green Sunfish	1	.3	100
Largemouth Bass	1	.3	100
Northern Pike			
Notropis Sp.	69	19.5	0
Orangespot Sunfish	2	.6	100
Redhorse	3	.8	100
Sauger	8	2.2	75
Shortnose Gar	1	.3	0
Walleye			
White Bass	18	5.1	100
Yellow Perch	3	.8	100
Total	354		

Source: Baldwin and Hey [18]

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May 1974

(Backwaters - a total of 475 ft were seined)

Species	Number	Mean Length	Range
Carpsucker	17	121 mm	60-390 mm
Crappie	2	110	
Goldeye	1	380	
Notropis sp.	5		
Shortnose Gar	11	549	500-640
White Sucker	1	110	
Total	37		

(Sand Bars - a total of 400 ft were seined)

Species	Number	Mean Length	Range
Carp	1	230	
Carpsucker	1	80	
Gizzard Shad	1	250	
Notropis	23		
Shortnose Gar	3	513	450-570 mm
Total	29		

Source: Baldwin and Hey 18/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SUMMARY OF MISSOURI RIVER
BACKWATERS SEINING DATA, 1971 - 1975
(SHEET 5 OF 7)

DATE: SCALE:

TABLE
A-III-C-4
(Cont'd)

July 1974 (a total of 1025 ft were seined.
725 ft were in backwaters -
300 ft were along sandbars)

Species	No.	Percent Abundance	Percent Young of Year
Carp	1	0.2	0
Carpsucker	7	1.2	14
Channel Catfish			
Crappie	47	8.0	98
Freshwater Drum	2	0.3	100
Gizzard Shad	495	84.3	100
Northern Pike			
River Redhorse			
Sauger			
Shortnose Gar			
Walleye			
White Bass	34	5.8	100
Yellow Perch	1	0.2	1
Total	587		

November 1974 (a total of 745 ft were seined.
440 ft were in backwaters,
305 ft were along sandbars and shores.)

Species	No.	Percent Abundance	Percent Young of Year
Bluegill	16	9.1	100
Carp	1	0.6	0
Carpsucker	31	17.6	80.6
Crappie	79	44.9	100
Freshwater Drum	2	1.1	100
Gizzard Shad	21	11.9	100
Johnny Darter	1	0.6	0
Green Sunfish			
Largemouth Bass	1	0.6	100
Longnose Gar	1	0.6	0
Orangespot Sunfish	2	1.1	100
Perch	3	1.7	100
River Redhorse	4	2.3	100
Sauger	3	1.7	100
Shortnose Gar			
White Bass	7	4.0	100
White Sucker	4	2.3	
Yellow Perch			
Total	176		

Source: Baldwin and Hey[17]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SUMMARY OF MISSOURI RIVER
BACKWATERS SEINING DATA, 1971 - 1975
(SHEET 6 OF 7)

DATE: SCALE:

TABLE
A-III-C-4
(Cont'd)

May 1975 - (a total of 350 ft were seined.
150 ft were in backwaters
200 ft were along shorelines and sandbars)

Species	No.	Mean Length	Range
Carp	2	417 mm	335-500 mm
Carpsucker	3	93	70-130
Goldeye	7	318	260-410
Notropis	123	31	10-70
Sauger	1	380	
Shortnose Gar	2	605	590-620
White Bass	1	120	
Total	139		

October 1975 - (a total of 200 ft were seined.
All seining was along sandbars)

Species	No.	Mean Length	Range
Carpsucker	1	120 mm	
Channel Catfish	6	100	100-100 mm
Notropis	80	*	50-110
White Bass	2	100	100-100
Total	89		

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

SUMMARY OF MISSOURI RIVER
BACKWATERS SEINING DATA, 1971 - 1975
(SHEET 7 OF 7)

DATE:

SCALE:

TABLE
A-III-C-4
(Cont'd)

EXHIBITS A-III-C-1 THROUGH A-III-C-11

TRELLIS DIAGRAMS SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS

TRELLIS DIAGRAM

The following trellis diagrams provide a numerical measure of similarity between all possible station pairs for the dates indicated. The values are calculated by determining the relative abundances of the species found at each station and then, taking one pair of species at a time, summing the smaller percentage for all similiar species. The diagram is read for the numerical similarity value for any two stations (say a and b where a > b) by finding the row on the Y axis for station b and the column on the X axis for station a. The similarity value is found at the point at which the column and row intersect.

Numerical values are represented by graphical patterns underneath the diagonal of the trellis diagram, so that clusters of stations are more readily apparent. The diagram is symmetric; however categories of similarity values were chosen to highlight stations of relatively higher or lower similarity.

STATION

STATION	1	2	3	4	5	6	7	8
1	GGG GGG GGG	98	98	78	98	95	95	98
2	GGG GGG GGG	GGG GGG GGG	97	77	97	93	95	98
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	78	97	96	95	98
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	79	79	76	78
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	94	96	96
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	92	94
7	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	94
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS MAY, 1973

DATE: SCALE:

EXHIBIT
A-III-C-1

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	94	92	21	94	92	95
2	GGG GGG GGG	GGG GGG GGG	95	19	94	96	98
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	20	92	98	96
4	OOO OOO OOO	OOO OOO OOO	OOO OOO OOO	GGG GGG GGG	25	20	19
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	OOO OOO OOO	GGG GGG GGG	92	94
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	OOO OOO OOO	GGG GGG GGG	GGG GGG GGG	95
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	OOO OOO OOO	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS
JUNE 1973

DATE: SCALE:

EXHIBIT
A-III-C-2

STATION

	1	2	3	4	5	6	8
1	GGG GGG GGG	86	78	81	81	82	86
2	GGG GGG GGG	GGG GGG GGG	86	86	84	83	79
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	88	87	83	79
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	83	84	82
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	86	74
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	80
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

STATION

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS
JULY 1973

DATE: SCALE:

EXHIBIT
A-III-C-3

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	91	78	25	79	81	92
2	GGG GGG GGG	GGG GGG GGG	78	26	81	83	93
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	41	93	85	79
4	000 000 000	000 000 000	XXX XXX XXX	GGG GGG GGG	39	35	26
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	XXX XXX XXX	GGG GGG GGG	84	79
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	83
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	000 000 000	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS AUGUST 1973

DATE: SCALE:

EXHIBIT A-III-C-4

STATION

STATION	1	2	3	4	6	8
1	GGG GGG GGG	87	90	86	84	90
2	GGG GGG GGG	GGG GGG GGG	90	81	87	91
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	85	87	90
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	81	84
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	84
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS SEPTEMBER 1973

DATE: SCALE:

EXHIBIT A-III-C-5

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	83	72	66	68	73	70
2	GGG GGG GGG	GGG GGG GGG	81	68	76	80	78
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	76	92	89	84
4	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	78	82	64
5	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	87	87
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	84
8	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS OCTOBER 1973

DATE: **SCALE:**

EXHIBIT A-III-C-6

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	85	80	82	78	80	83
2	GGG GGG GGG	GGG GGG GGG	88	93	89	90	92
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	87	87	86	89
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	90	91	90
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	93	91
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	94
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS DECEMBER 1973

DATE: SCALE:

EXHIBIT A-III-C-7

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	91	93	93	83	93	91
2	GGG GGG GGG	GGG GGG GGG	91	96	78	98	96
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	94	77	91	89
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	77	97	94
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	78	76
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	97
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS JANUARY 1974

DATE: SCALE:

EXHIBIT A-III-C-8

STATION

STATION

	1	2	3	5	6	8
1	GGG GGG GGG	88	87	80	75	88
2	GGG GGG GGG	GGG GGG GGG	94	87	83	95
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	91	86	99
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	93	92
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	87
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS FEBRUARY 1974

DATE:

EXHIBIT

A-III-C-9

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	97	91	92	92	89	94
2	GGG GGG GGG	GGG GGG GGG	94	91	93	87	93
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	87	97	83	87
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	85	93	96
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	82	87
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	91
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS MARCH 1974

DATE:

EXHIBIT

A-III-C-10

STATION

STATION	1	2	3	4	5	6	8
1	GGG GGG GGG	87	83	83	90	88	98
2	GGG GGG GGG	GGG GGG GGG	95	95	96	97	88
3	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	97	92	94	84
4	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	92	94	84
5	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	98	91
6	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	90
8	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING PHYTOPLANKTON SIMILARITIES BETWEEN ALL PAIRS OF STATIONS
APRIL 1974

DATE:

EXHIBIT

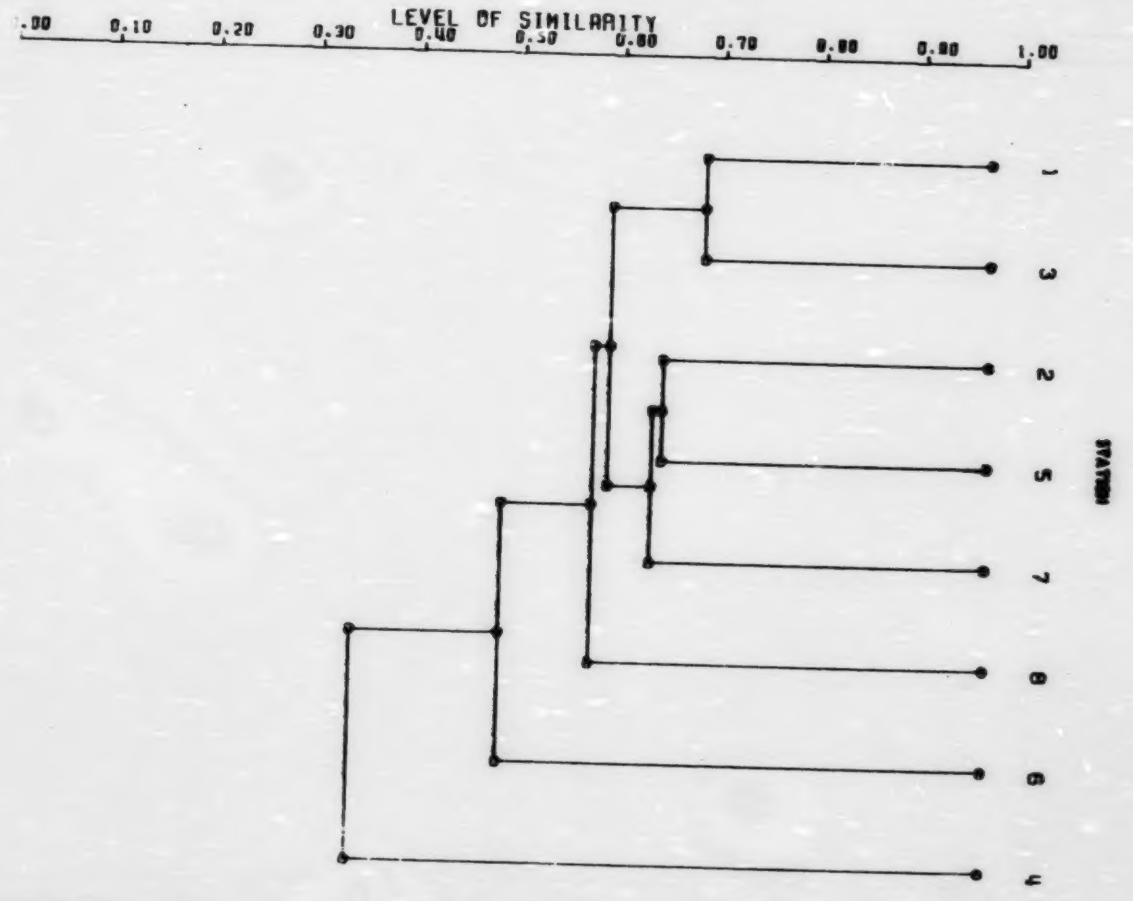
A-III-C-11

EXHIBITS A-III-C-12 THROUGH A-III-C-20

DENDOGRAMS SHOWING PHYTOPLANKTON
SIMILARTIES (SCALED ABUNDANCE
COEFFICIENT) BETWEEN ALL PAIRS OF STATIONS
MAY 1973 - FEBRUARY 1974

DENDROGRAMS

The following dendrograms are constructed such that stations with the highest degree of similarity are connected first, and then joined to stations or groups of stations in order of their degree of similarity. The degree of similarity between stations and/or station groups can be found by reading the level at which the horizontal connecting lines are found on the Y axis.



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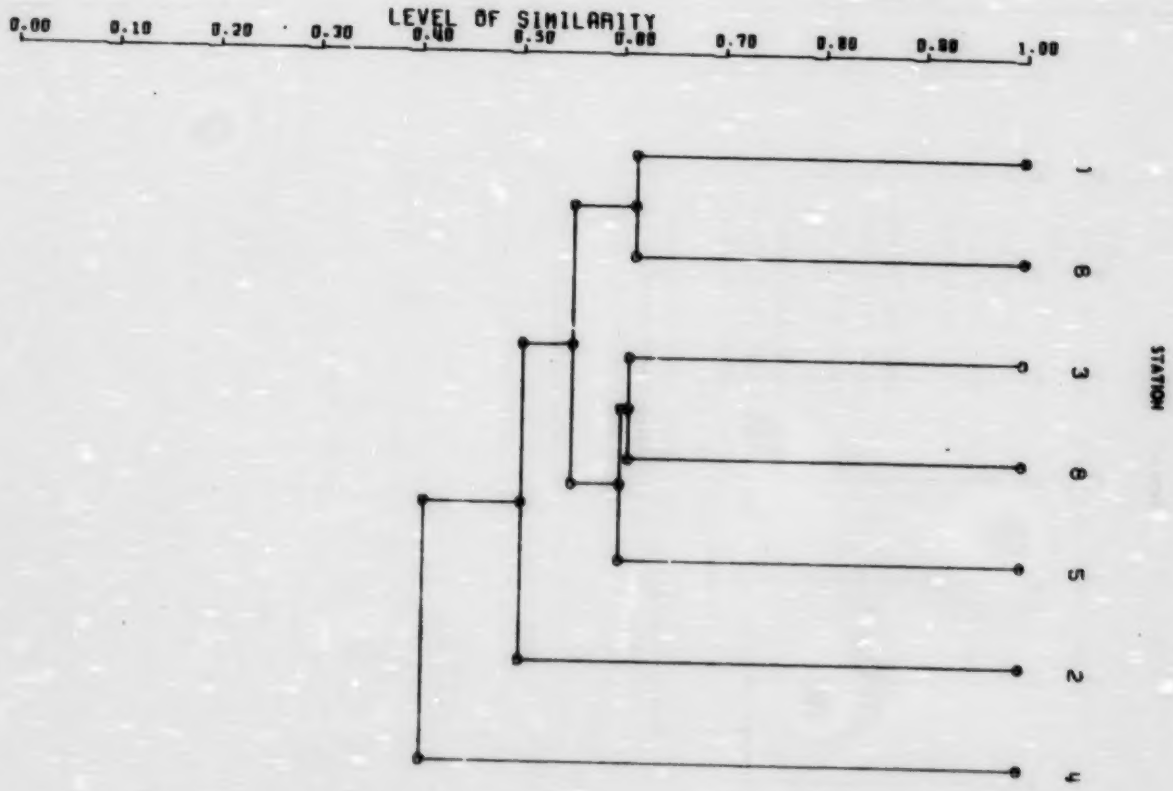
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, MAY 1973

DATE:

SCALE:

EXHIBIT
A-III-C-12



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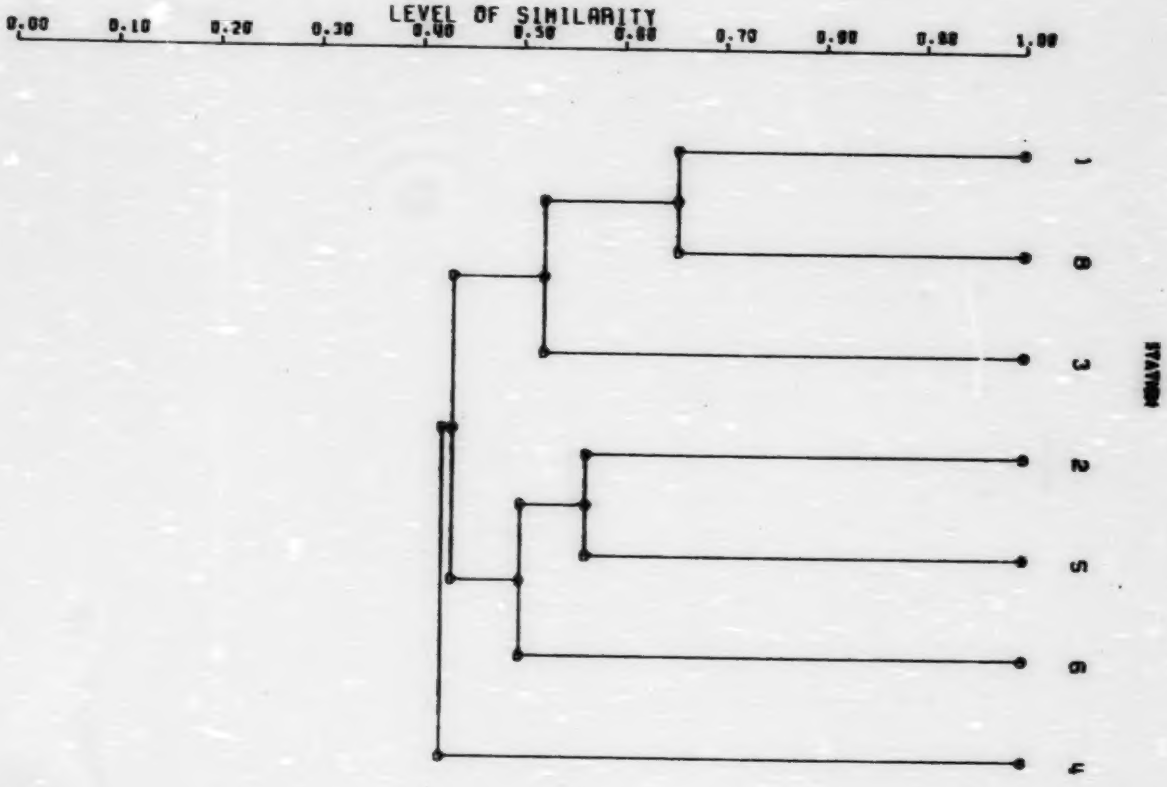
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS JUNE 1973

DATE:

SCALE:

EXHIBIT
A-III-C-13



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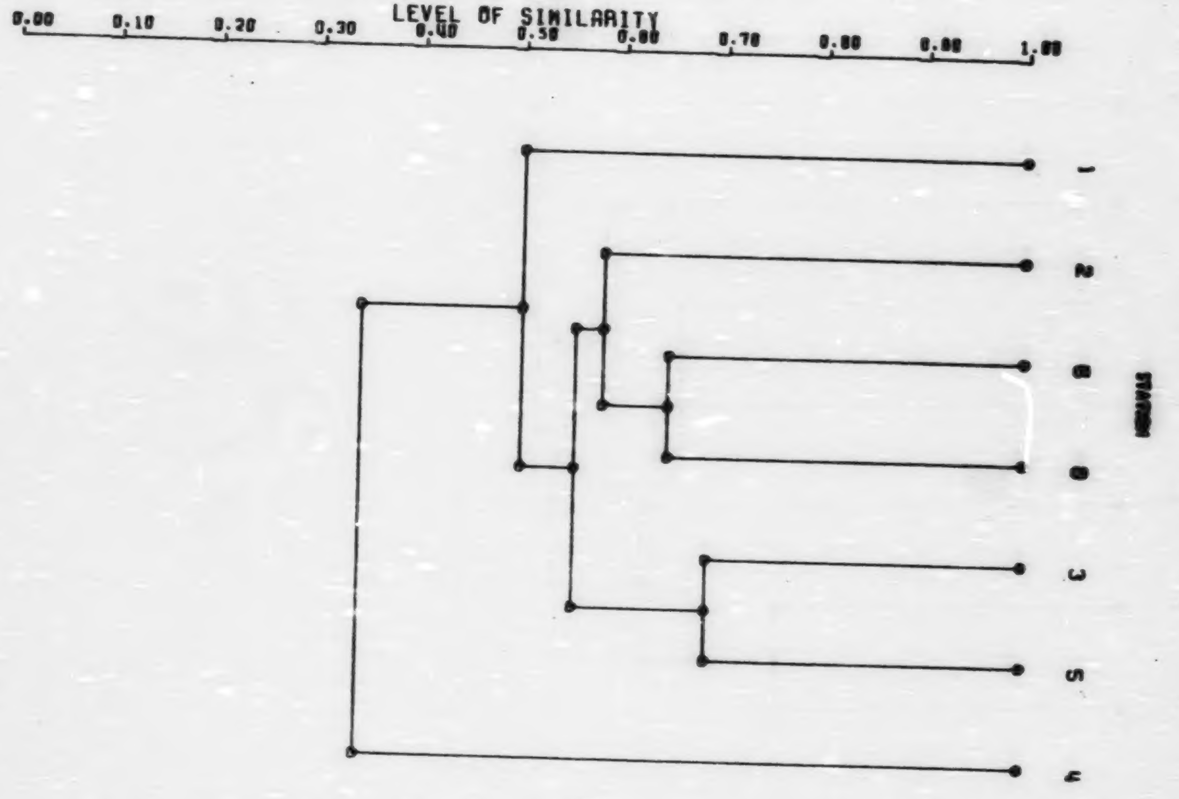
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, JULY 1973

DATE:

SCALE:

EXHIBIT
A-III-C-14



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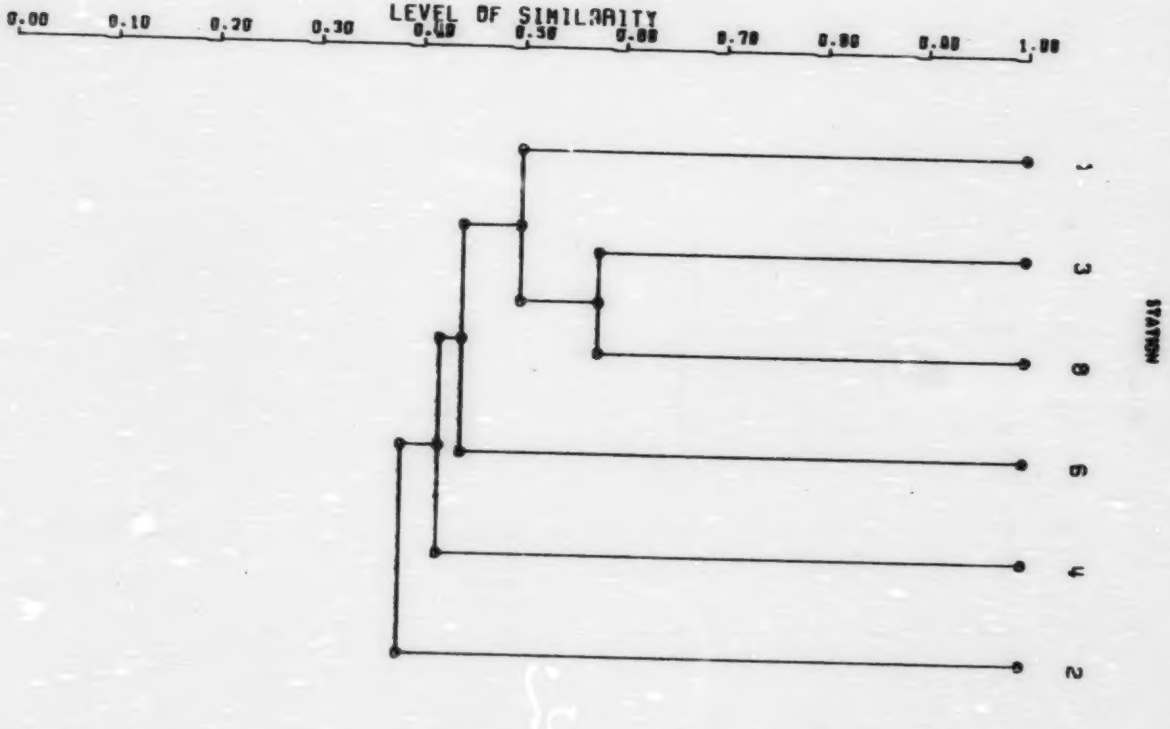
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, AUGUST 1973

DATE:

SCALE:

EXHIBIT
A-III-C-15



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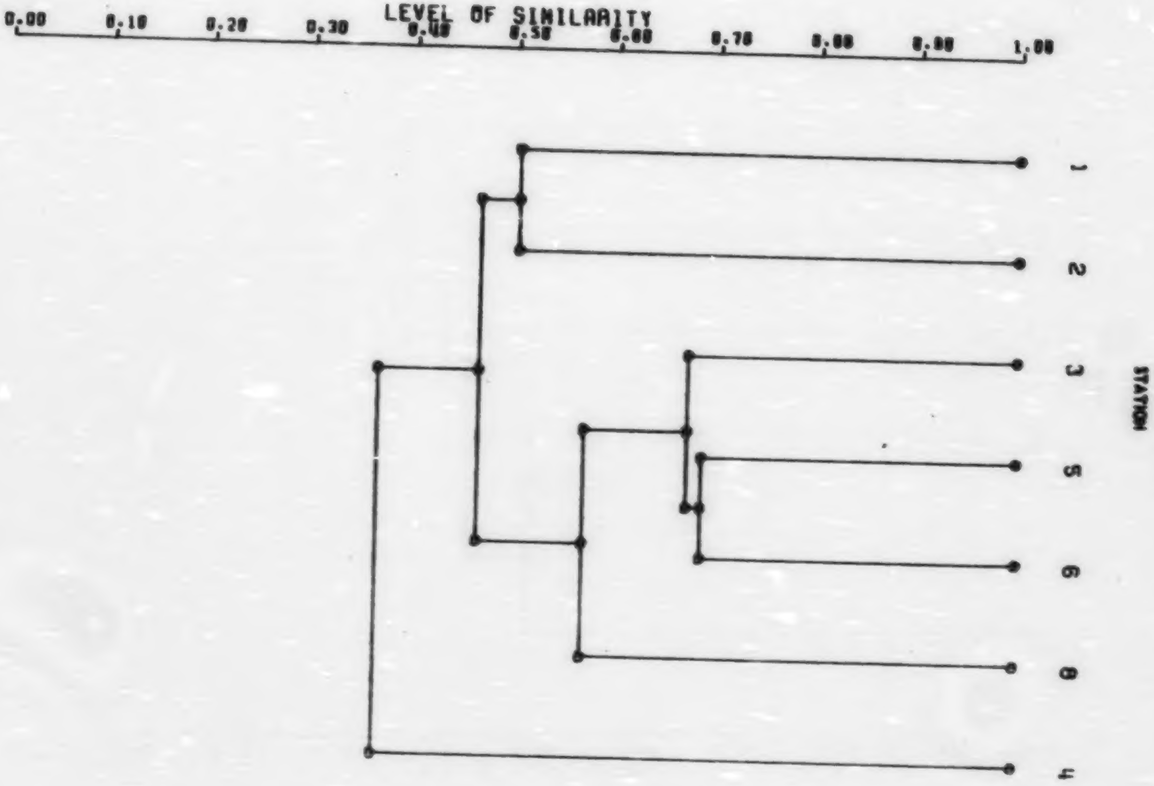
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, SEPTEMBER 1973

DATE:

SCALE:

EXHIBIT
A-III-C-16



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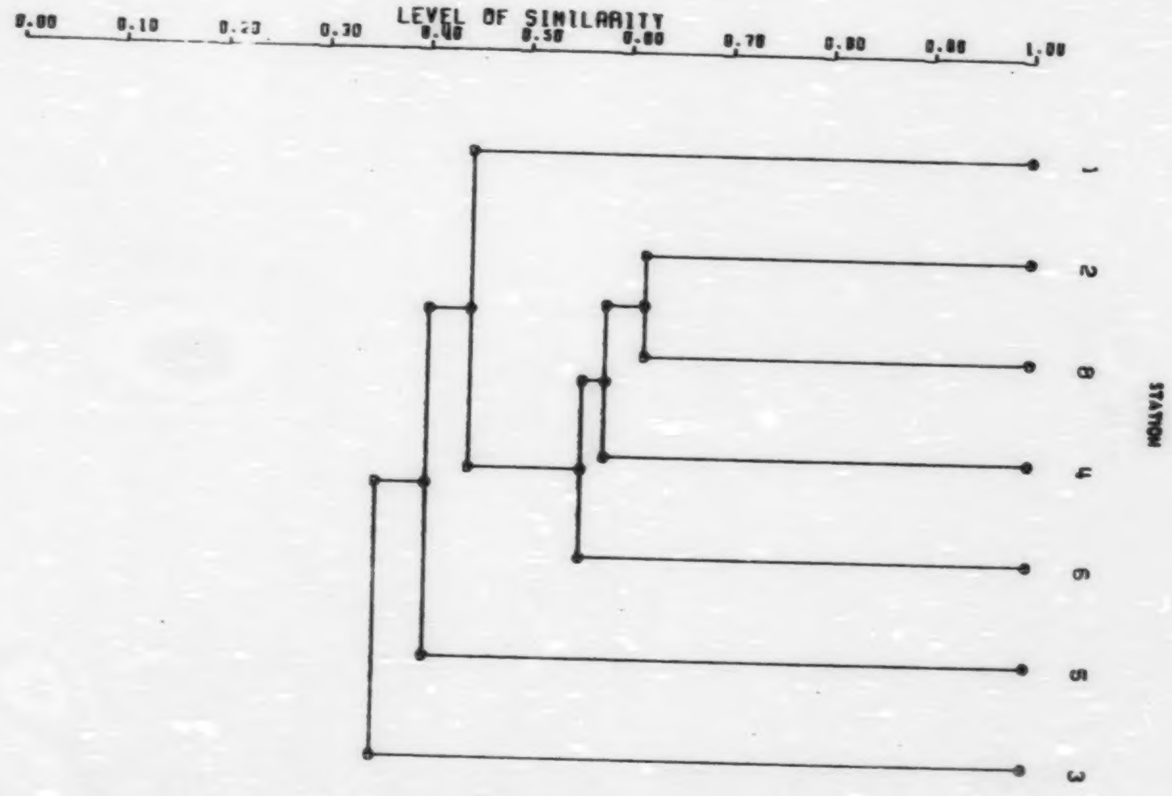
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, OCTOBER 1973

DATE:

SCALE:

EXHIBIT
A-III-C-17



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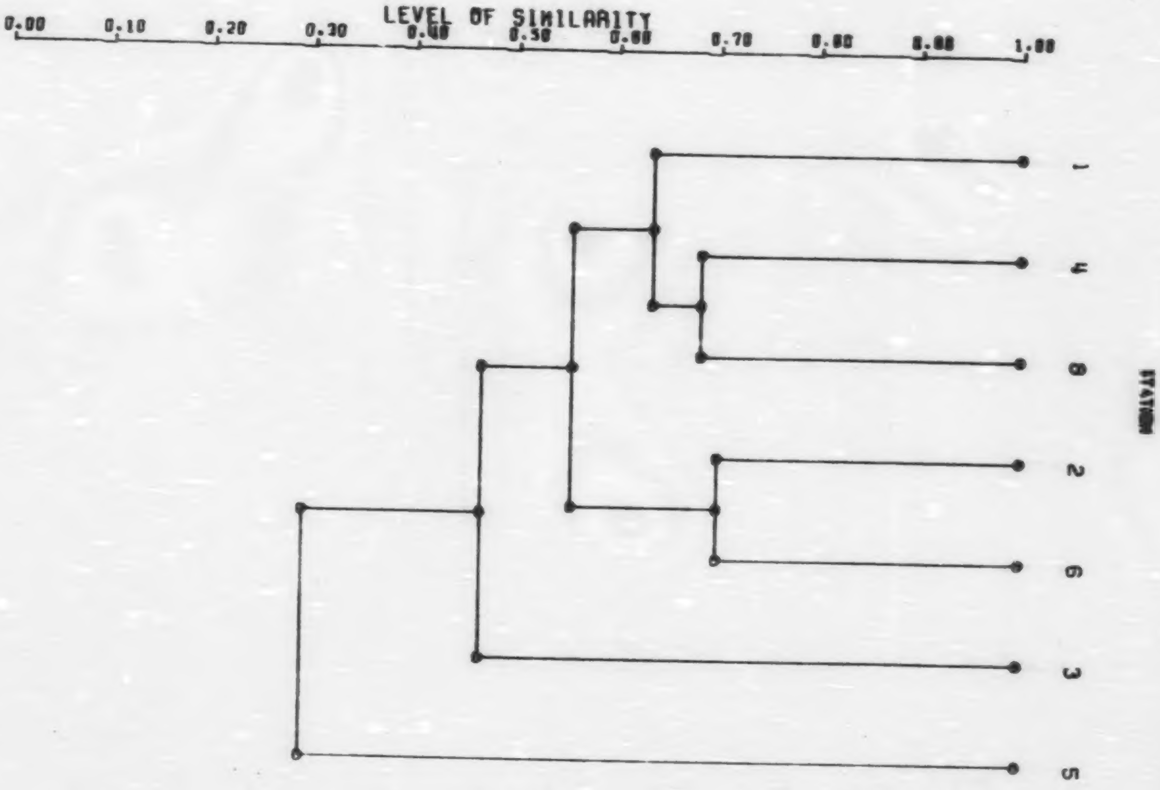
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, DECEMBER 1973

DATE:

SCALE:

EXHIBIT
A-III-C-18



IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS JANUARY 1974

DATE:

SCALE:

EXHIBIT
A-III-C-19

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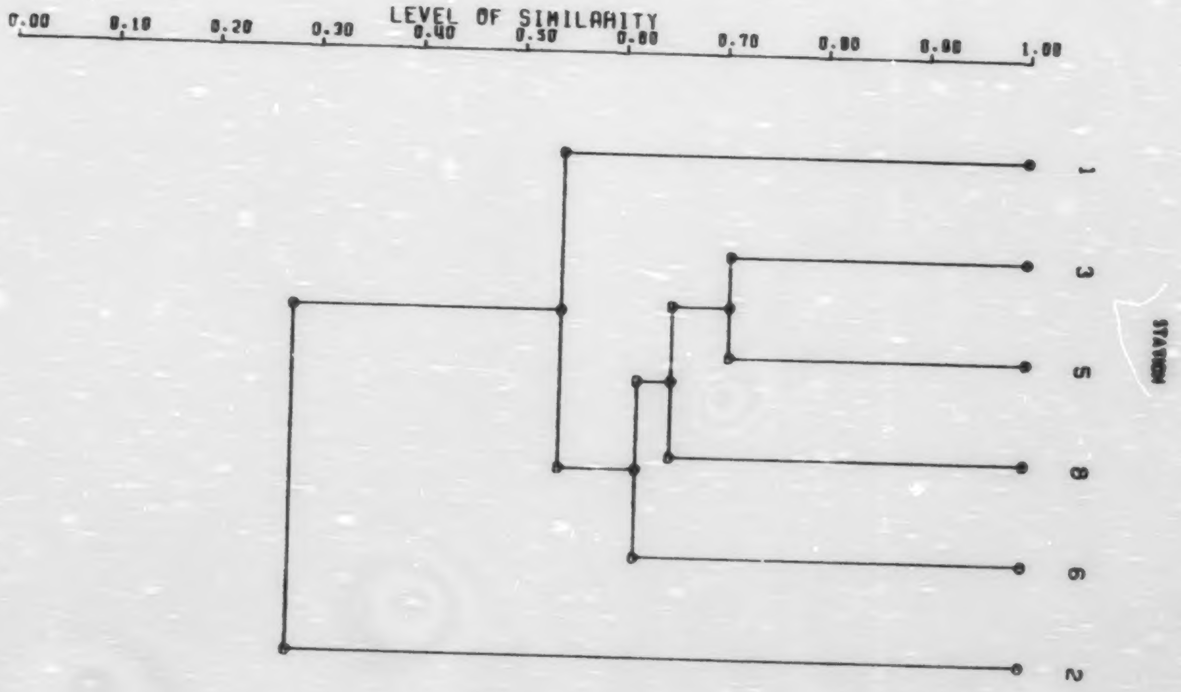

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(SCALED ABUNDANCE COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, FEBRUARY 1974

DATE:

SCALE:

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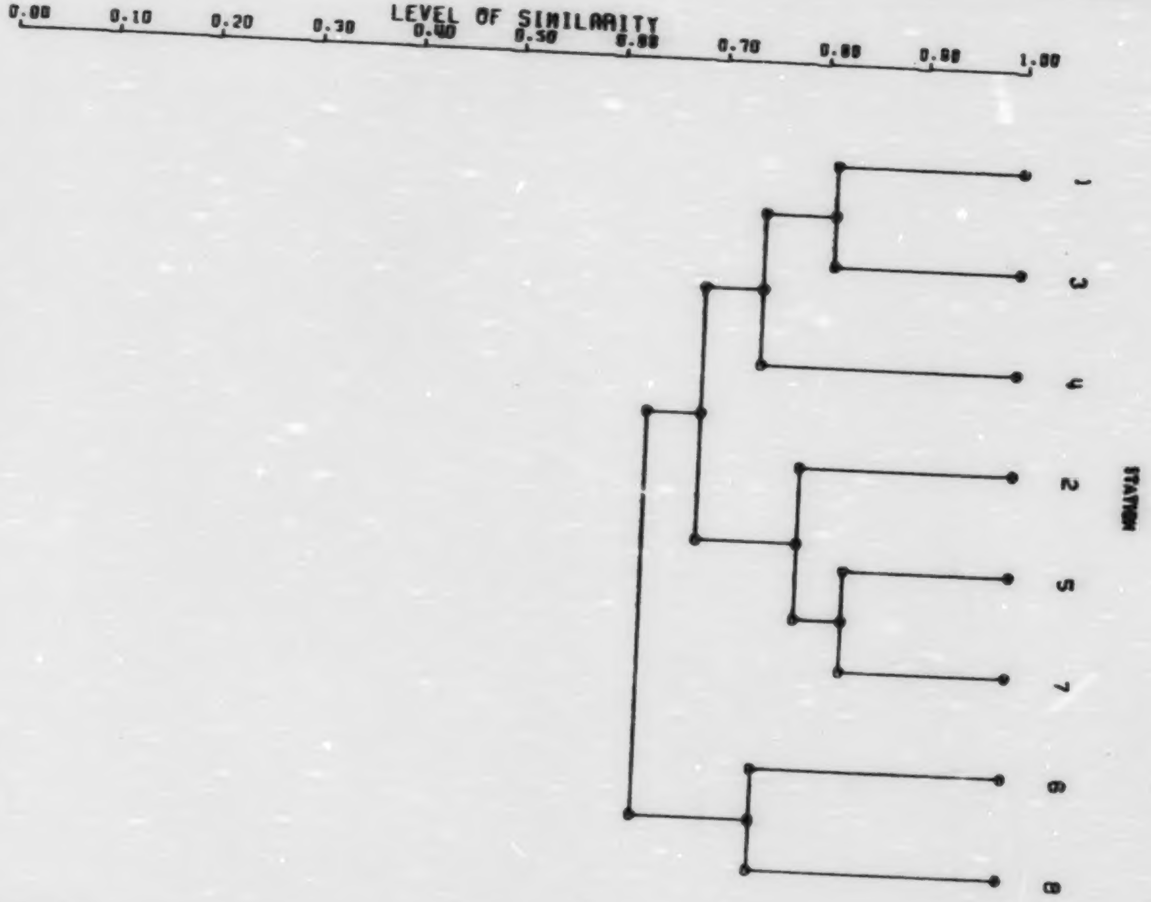
EXHIBIT
A-III-C-20

EXHIBITS A-III-C-21 THROUGH A-III-C-29

DENDOGRAMS SHOWING PHYTOPLANKTON
SIMILARITIES (JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS
MAY 1973 - FEBRUARY 1974



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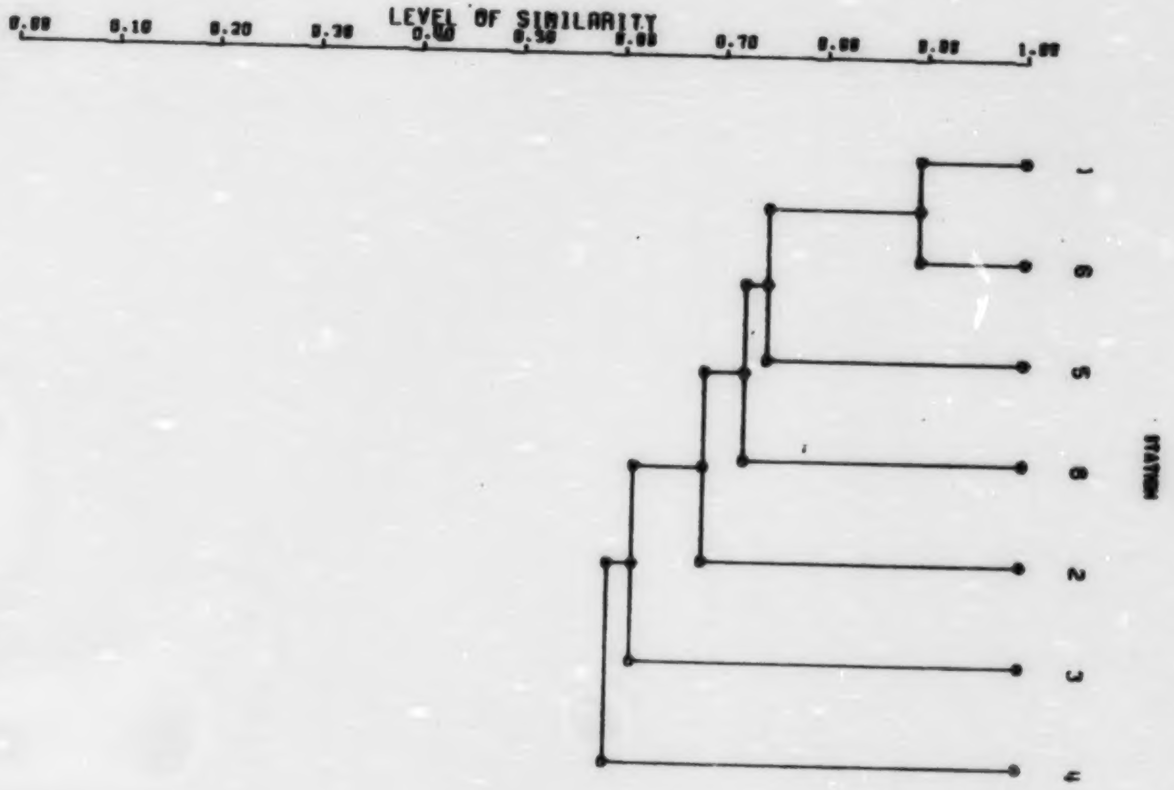
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, MAY 1973

DATE:

SCALE:

EXHIBIT
A-III-C-21



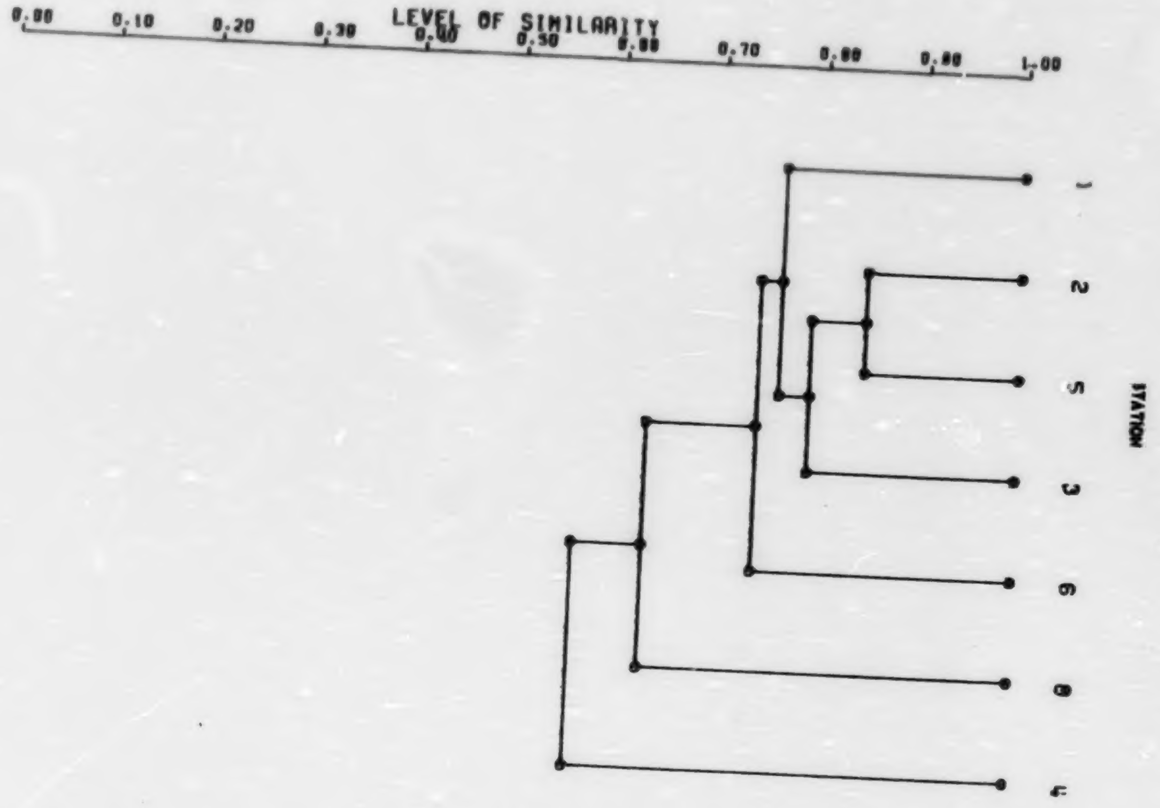
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, JUNE 1973

DATE:

SCALE:

EXHIBIT
A-III-C-22



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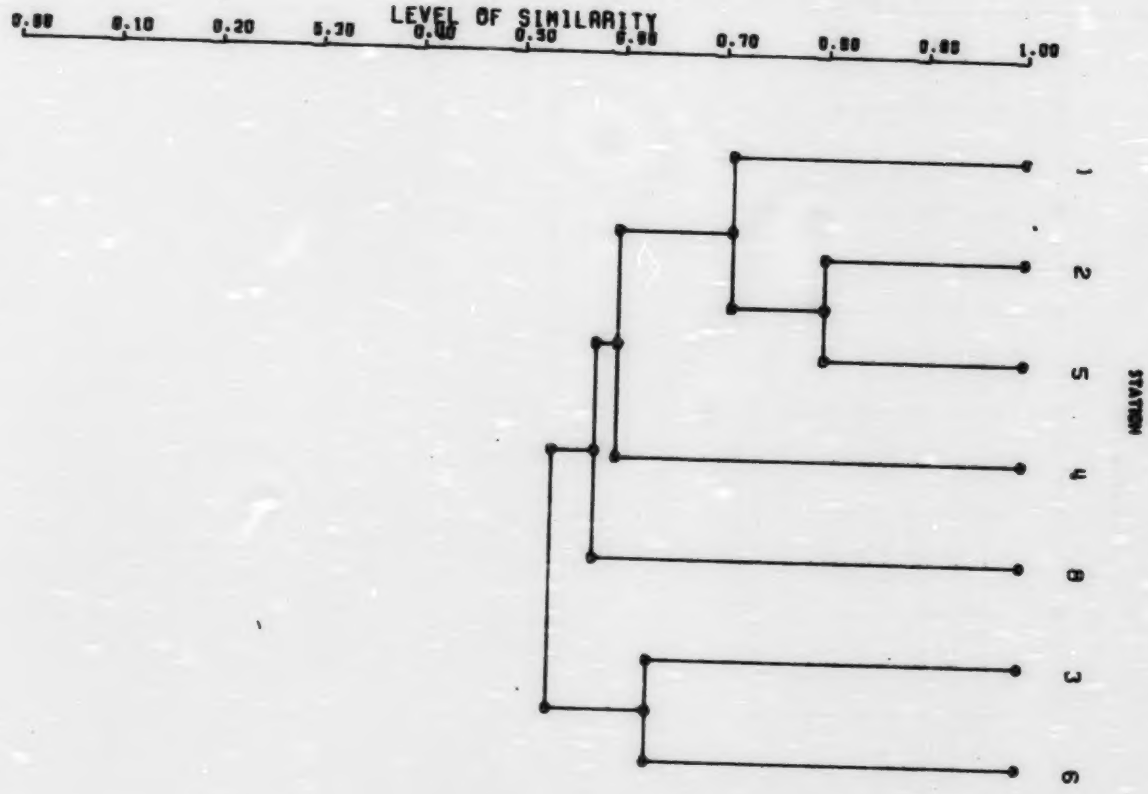
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, JULY 1973

DATE:

SCALE:

EXHIBIT
A-III-C-23



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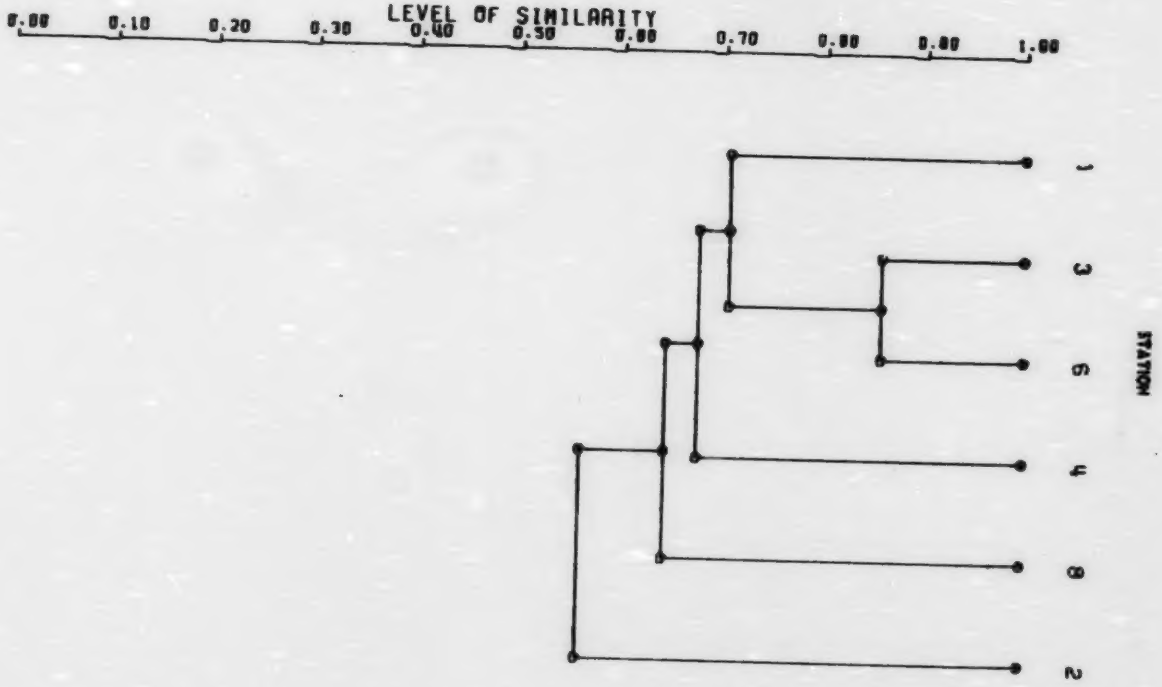
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, AUGUST 1973

DATE:

SCALE:

EXHIBIT
A-III-C-24



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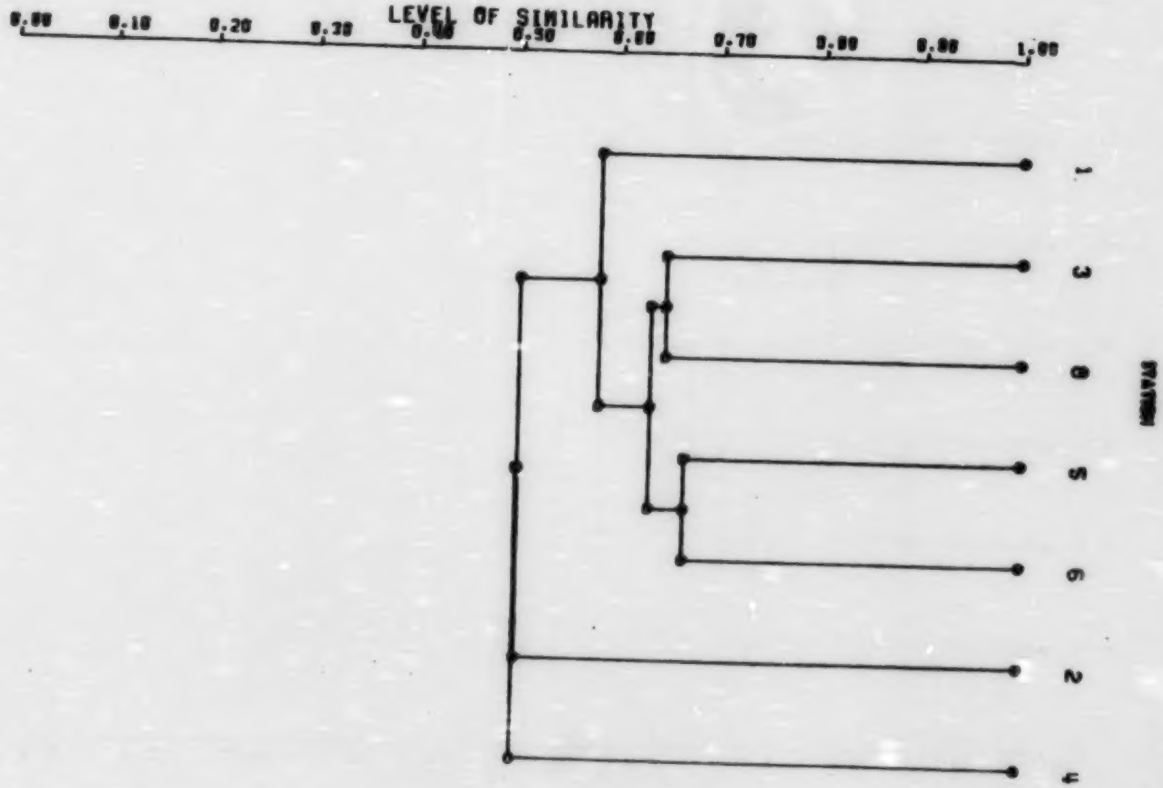
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, SEPTEMBER 1973

DATE:

SCALE:

EXHIBIT
A-III-C-25



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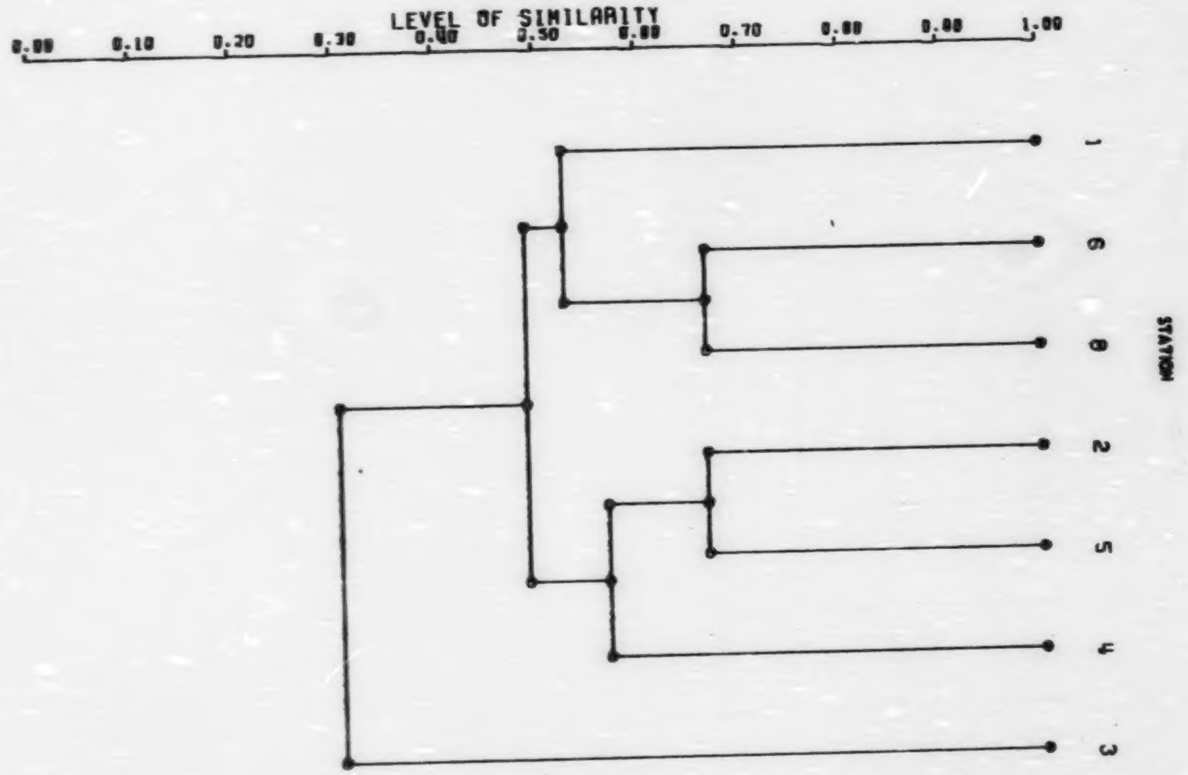
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, OCTOBER 1973

DATE:

SCALE:

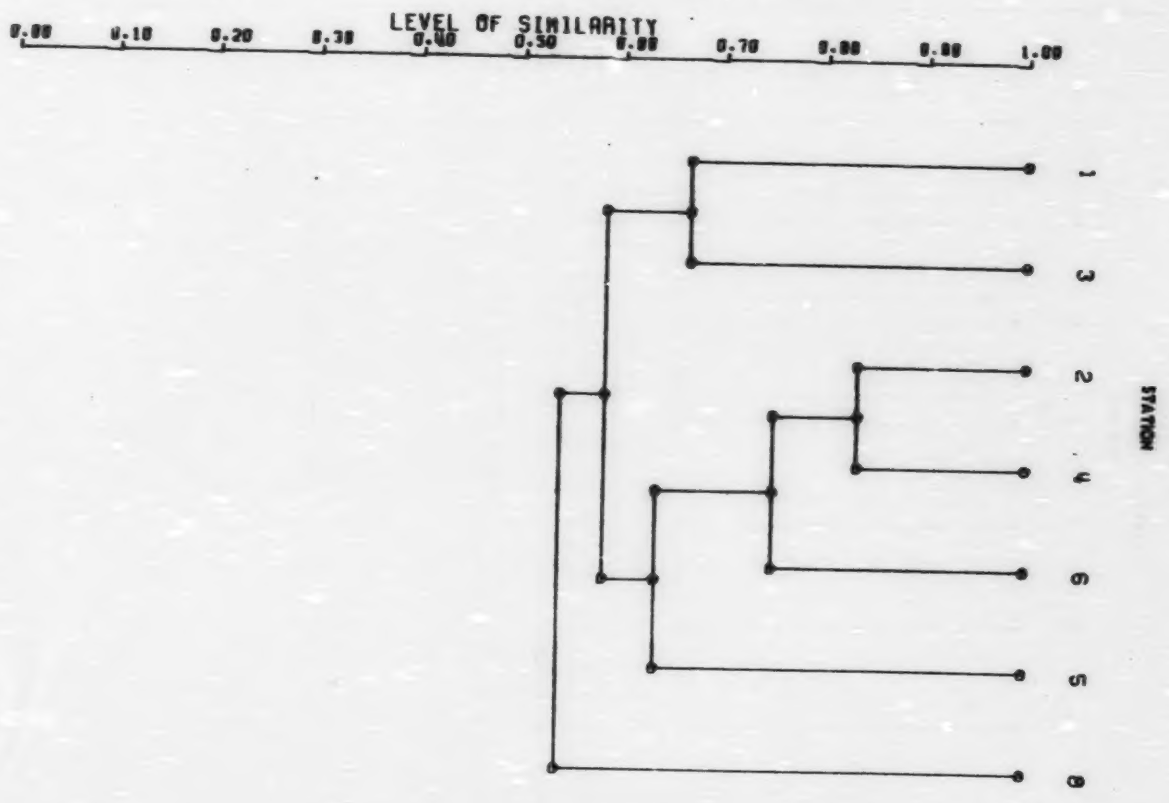
EXHIBIT
A-III-C-26



IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, DECEMBER 1973

DATE:
SCALE:

EXHIBIT
A-III-C-27



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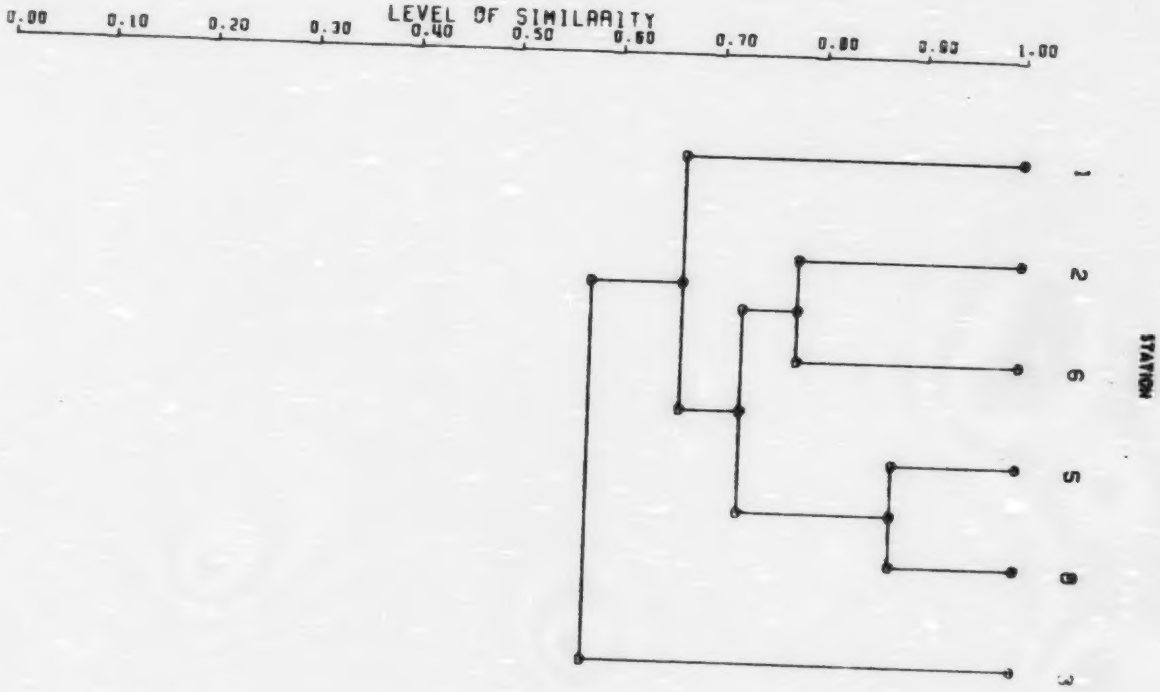
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES
(JACCARD COEFFICIENT)
BETWEEN ALL PAIRS OF STATIONS, JANUARY 1974

DATE:

SCALE:

EXHIBIT
A-III-C-28



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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

DENDROGRAM SHOWING PHYTOPLANKTON SIMILARITIES

JACCARD COEFFICIENT

BETWEEN ALL PAIRS OF STATIONS, FEBRUARY 1974

DATE:

SCALE:

EXHIBIT
A-III-C-29

EXHIBITS A-III-C-30 THROUGH A-III-C-36

TRELLIS DIAGRAMS SHOWING MACROINVERTEBRATE
SIMILARITIES BETWEEN ALL PAIRS OF
SUBSTRATE SAMPLERS
MID APRIL 1973 - MID NOVEMBER 1973

Reproduced from best available copy.

STATION

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23	24
1	GGG	74	72	61	60	71	80	59	67	82	62	63	54	65	52	56	58	59	51	57	50
2	GGG	GGG	72	71	72	70	74	68	74	81	67	58	66	65	68	69	72	85	66	83	71
3	GGG	GGG	GGG	78	77	61	71	84	64	86	82	78	50	71	50	76	78	60	50	65	65
4	MMM	GGG	GGG	GGG	81	74	64	86	85	76	[illegible]	78	68	78	63	88	68	70	66	78	63
5	MMM	GGG	GGG	GGG	GGG	75	70	80	82	77	82	70	62	76	64	66	86	68	67	72	58
6	GGG	MMM	GGG	GGG	GGG	GGG	72	78	76	87	77	73	47	69	50	76	77	57	49	62	42
7	GGG	GGG	GGG	MMM	MMM	GGG	GGG	62	61	80	61	51	62	58	60	64	62	62	65	59	58
8	MMM	MMM	GGG	GGG	GGG	GGG	MMM	GGG	92	76	89	86	54	74	59	86	80	69	60	72	54
9	MMM	GGG	GGG	GGG	GGG	GGG	MMM	GGG	GGG	72	[illegible]	81	61	75	61	84	85	71	62	76	56
10	GGG	GGG	GGG	GGG	GGG	GGG	GGG	GGG	GGG	GGG	75	66	54	72	58	74	77	68	60	72	55
11	MMM	MMM	GGG	GGG	GGG	GGG	MMM	GGG	GGG	GGG	GGG	42	54	71	54	41	62	65	61	49	55
12	MMM	MMM	GGG	GGG	MMM	GGG	MMM	GGG	GGG	MMM	GGG	GGG	50	70	50	75	76	58	50	65	[illegible]
13	MMM	MMM	III	MMM	MMM	III	MMM	MMM	MMM	MMM	MMM	III	GGG	74	81	71	66	72	77	[illegible]	74
14	MMM	MMM	GGG	GGG	GGG	MMM	MMM	GGG	GGG	GGG	GGG	MMM	GGG	GGG	72	82	[illegible]	67	58	74	54
15	MMM	MMM	III	MMM	MMM	III	MMM	MMM	MMM	MMM	MMM	III	GGG	GGG	GGG	67	71	71	64	[illegible]	66
16	MMM	MMM	GGG	GGG	GGG	GGG	MMM	GGG	GGG	GGG	GGG	GGG	MMM	GGG	MMM	GGG	42	75	70	[illegible]	54
17	MMM	GGG	GGG	GGG	GGG	GGG	MMM	GGG	GGG	GGG	GGG	GGG	MMM	GGG	GGG	GGG	GGG	76	66	80	61
18	MMM	GGG	MMM	MMM	MMM	MMM	MMM	MMM	GGG	MMM	MMM	MMM	GGG	MMM	GGG	GGG	GGG	GGG	74	41	85
22	MMM	MMM	III	MMM	MMM	III	MMM	MMM	MMM	MMM	MMM	III	GGG	MMM	MMM	MMM	MMM	GGG	GGG	64	74
23	MMM	GGG	MMM	GGG	GGG	MMM	MMM	GGG	GGG	GGG	MMM	MMM	MMM	GGG	GGG	GGG	GGG	GGG	MMM	GGG	40
24	III	GGG	III	MMM	MMM	III	MMM	MMM	MMM	MMM	MMM	III	GGG	MMM	MMM	MMM	MMM	GGG	GGG	GGG	GGG

% SIMILARITY

GGG	III	MMM	· · ·
0-30	31-50	51-70	71-100

envirosphere company

A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING
MACROINVERTEBRATE SIMILARITIES
BETWEEN ALL PAIRS OF SUBSTRATE
SAMPLERS MID APRIL - MID MAY, 1973

DATE:

EXHIBIT

A-III-C-30

STATION

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	GGG	74	74	24	44	36	7	41	44	62	64	59	46	13	24	17	27	39
2	GGG	GGG	85	24	24	26	7	39	40	54	77	56	61	13	24	17	28	54
3	GGG	GGG	GGG	22	35	35	7	34	37	55	71	65	57	13	23	16	27	53
4	OOO	OOO	OOO	GGG	79	77	82	78	73	47	33	45	53	86	94	92	92	60
5	XXX	OOO	XXX	GGG	GGG	85	61	84	74	58	44	63	57	65	76	71	76	61
6	XXX	OOO	XXX	GGG	GGG	GGG	66	73	68	49	33	54	51	70	74	73	73	55
7	OOO	OOO	OOO	GGG	MMM	MMM	GGG	60	58	29	17	28	38	93	81	88	78	45
8	XXX	XXX	XXX	GGG	GGG	GGG	MMM	GGG	89	61	52	58	64	64	76	71	82	74
9	XXX	XXX	XXX	GGG	GGG	MMM	MMM	GGG	GGG	62	56	67	77	61	71	67	78	80
10	MMM	MMM	MMM	XXX	MMM	XXX	OOO	MMM	MMM	GGG	62	75	67	33	45	40	51	66
11	MMM	GGG	GGG	XXX	XXX	XXX	OOO	MMM	MMM	MMM	GGG	70	64	22	31	26	37	64
12	MMM	MMM	MMM	XXX	MMM	MMM	OOO	MMM	MMM	GGG	MMM	GGG	75	32	42	38	48	72
13	XXX	MMM	MMM	MMM	MMM	MMM	XXX	MMM	GGG	MMM	MMM	GGG	GGG	43	54	50	59	86
14	OOO	OOO	OOO	GGG	MMM	MMM	GGG	MMM	MMM	XXX	OOO	XXX	XXX	GGG	86	93	82	50
15	OOO	OOO	OOO	GGG	GGG	GGG	GGG	GGG	GGG	XXX	XXX	XXX	MMM	GGG	GGG	92	92	59
16	OOO	OOO	OOO	GGG	GGG	GGG	GGG	GGG	MMM	XXX	OOO	XXX	XXX	GGG	GGG	GGG	87	54
17	OOO	OOO	OOO	GGG	GGG	GGG	GGG	GGG	GGG	MMM	XXX	XXX	MMM	GGG	GGG	GGG	GGG	66
18	XXX	MMM	MMM	MMM	MMM	MMM	XXX	GGG	GGG	MMM	MMM	GGG	GGG	XXX	MMM	MMM	MMM	GGG

% SIMILARITY

OOO	XXX	MMM	GGG
0-30	31-50	51-70	71-100

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING
MACROINVERTEBRATE SIMILARITIES
BETWEEN ALL PAIRS OF SUBSTRATE
SAMPLERS MID MAY - MID JUNE, 1973

DATE:

EXHIBIT

A-III-C-31

STATION

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23	24
1	GGG GGG GGG	64	66	58	63	67	63	59	59	62	60	57	59	51	42	62	62	37	53	45	49
2	HHH HHH HHH	GGG GGG GGG	84	66	68	64	69	83	74	70	77	62	59	82	41	82	89	69	82	74	78
3	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	70	67	61	68	84	75	74	74	61	70	81	45	83	86	65	76	69	73
4	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	76	60	84	72	70	69	64	59	70	59	57	56	62	52	55	48	52
5	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	74	82	74	72	73	67	73	66	56	49	59	65	49	56	42	46
6	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	66	68	80	84	76	88	49	52	43	59	60	37	55	41	45
7	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	73	70	78	64	64	73	57	58	58	64	54	55	46	58
8	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	86	78	84	65	66	74	39	73	79	65	80	66	78
9	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	90	92	78	64	65	38	64	70	55	70	56	68
10	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	88	84	61	61	42	59	64	45	65	51	55
11	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	76	60	68	37	67	72	55	75	68	65
12	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	49	53	45	52	56	34	53	39	43
13	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	GGG GGG GGG	66	54	70	68	61	49	47	53
14	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	54	82	83	67	69	67	73
15	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	49	48	26	27	24	31
16	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	XXX XXX XXX	GGG GGG GGG	92	70	68	66	72
17	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	71	74	72	78
18	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	OOO OOO OOO	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	76	79	81
22	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	OOO OOO OOO	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	85	86
23	XXX XXX XXX	GGG GGG GGG	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	OOO OOO OOO	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	93
24	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING
MACROINVERTEBRATE SIMILARITIES
BETWEEN ALL PAIRS OF SUBSTRATE
SAMPLERS MID JUNE - MID JULY, 1973

DATE:

EXHIBIT

A-III-C-32

STATION

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23	24
1	GGG	81	83	64	58	59	51	70	70	85	65	70	76	75	59	41	83	72	73	77	55
2	GGG	GGG	77	68	68	61	58	74	74	83	64	73	80	81	60	51	80	71	68	73	48
3	GGG	GGG	GGG	74	66	65	59	78	78	81	70	83	74	71	64	47	76	71	63	68	57
4	MMM	MMM	GGG	GGG	73	78	65	70	69	61	55	83	75	73	60	67	55	63	42	46	41
5	MMM	MMM	MMM	GGG	GGG	59	72	68	68	63	54	72	70	75	53	62	56	60	44	48	38
6	MMM	MMM	MMM	GGG	MMM	GGG	61	67	66	59	54	66	75	64	65	74	54	61	41	45	40
7	MMM	MMM	MMM	MMM	GGG	MMM	GGG	67	68	57	57	62	62	57	60	60	54	62	40	51	47
8	MMM	GGG	GGG	MMM	MMM	MMM	MMM	GGG	97	85	80	67	82	70	72	58	82	92	72	76	64
9	MMM	GGG	GGG	MMM	MMM	MMM	MMM	GGG	GGG	84	79	67	81	71	71	58	81	92	72	77	63
10	GGG	GGG	GGG	MMM	MMM	MMM	MMM	GGG	GGG	GGG	78	68	77	72	65	43	93	85	80	85	64
11	MMM	MMM	MMM	MMM	MMM	MMM	MMM	GGG	GGG	GGG	GGG	61	67	56	64	44	78	81	80	82	83
12	MMM	GGG	GGG	GGG	GGG	MMM	MMM	MMM	MMM	MMM	MMM	GGG	68	70	56	52	61	59	50	54	48
13	GGG	GGG	GGG	GGG	MMM	GGG	MMM	GGG	GGG	GGG	MMM	MMM	GGG	80	70	63	72	80	59	64	50
14	GGG	GGG	GGG	GGG	GGG	MMM	MMM	MMM	GGG	GGG	MMM	MMM	GGG	GGG	64	60	66	67	54	58	39
15	MMM	MMM	MMM	MMM	MMM	MMM	MMM	GGG	GGG	MMM	MMM	MMM	MMM	MMM	GGG	53	62	67	50	54	49
16	XXX	MMM	XXX	MMM	MMM	GGG	MMM	MMM	MMM	XXX	XXX	MMM	MMM	MMM	MMM	GGG	40	54	33	37	32
17	GGG	GGG	GGG	MMM	MMM	MMM	MMM	GGG	GGG	GGG	GGG	MMM	GGG	MMM	MMM	XXX	GGG	84	86	90	66
18	GGG	GGG	GGG	MMM	MMM	MMM	MMM	GGG	GGG	GGG	GGG	MMM	GGG	MMM	MMM	MMM	GGG	GGG	79	83	67
22	GGG	MMM	MMM	XXX	XXX	XXX	XXX	GGG	GGG	GGG	GGG	XXX	MMM	MMM	XXX	XXX	GGG	GGG	GGG	95	78
23	GGG	GGG	MMM	XXX	XXX	XXX	MMM	GGG	GGG	GGG	GGG	MMM	MMM	MMM	MMM	XXX	GGG	GGG	GGG	GGG	75
24	MMM	XXX	MMM	XXX	XXX	XXX	XXX	MMM	MMM	MMM	GGG	XXX	XXX	XXX	XXX	XXX	MMM	MMM	GGG	GGG	GGG

% SIMILARITY

000	XXX	MMM	GGG
0-30	31-50	51-70	71-100

envirosphere company

A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING
MACROINVERTEBRATE SIMILARITIES
BETWEEN ALL PAIRS OF SUBSTRATE
SAMPLERS MID JULY - MID AUGUST, 1973

DATE:

EXHIBIT

A-III-C-33

STATION

STATION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	22	23
1	GGG	79	78	56	33	33	34	20	27	37	52	54	61	73	66	29	70	70	30	42
2	GGG	GGG	88	64	44	44	45	30	39	50	62	64	66	79	74	39	81	80	40	44
3	GGG	GGG	GGG	60	37	37	36	21	30	43	56	59	58	70	66	35	76	75	29	46
4	HHH	HHH	HHH	GGG	74	63	67	61	62	71	73	77	75	82	84	54	71	81	64	45
5	XXX	XXX	XXX	GGG	GGG	78	62	64	62	69	64	65	51	56	61	55	49	59	83	34
6	XXX	XXX	XXX	HHH	GGG	GGG	72	65	70	84	69	70	62	56	65	72	56	60	64	39
7	XXX	XXX	XXX	HHH	HHH	GGG	GGG	83	92	83	55	58	70	60	66	83	48	58	57	33
8	000	000	000	HHH	HHH	HHH	GGG	GGG	89	71	40	43	58	45	51	73	36	44	58	19
9	000	XXX	000	HHH	HHH	HHH	GGG	GGG	GGG	79	48	52	63	53	59	82	45	53	54	28
10	XXX	XXX	XXX	GGG	HHH	GGG	GGG	GGG	GGG	GGG	67	70	72	64	70	80	61	66	54	46
11	HHH	HHH	HHH	GGG	HHH	HHH	HHH	XXX	XXX	HHH	GGG	94	68	72	75	65	75	76	55	64
12	HHH	HHH	HHH	GGG	HHH	HHH	HHH	XXX	HHH	HHH	GGG	GGG	71	75	80	67	76	79	54	60
13	HHH	HHH	HHH	GGG	HHH	HHH	HHH	HHH	HHH	GGG	HHH	GGG	GGG	83	89	64	69	81	47	38
14	GGG	GGG	HHH	GGG	HHH	HHH	HHH	XXX	HHH	HHH	GGG	GGG	GGG	GGG	90	54	84	92	50	44
15	HHH	GGG	HHH	GGG	HHH	HHH	HHH	HHH	HHH	HHH	GGG	GGG	GGG	GGG	GGG	60	77	89	53	45
16	000	XXX	XXX	HHH	HHH	GGG	GGG	GGG	GGG	GGG	HHH	HHH	HHH	HHH	HHH	GGG	56	58	43	44
17	HHH	GGG	GGG	GGG	XXX	HHH	XXX	XXX	XXX	HHH	GGG	GGG	HHH	GGG	GGG	HHH	GGG	86	40	52
18	HHH	GGG	GGG	GGG	HHH	HHH	HHH	XXX	HHH	HHH	GGG	GGG	GGG	GGG	GGG	HHH	GGG	GGG	48	45
22	000	XXX	000	HHH	GGG	HHH	HHH	HHH	HHH	HHH	HHH	HHH	XXX	XXX	HHH	XXX	XXX	XXX	GGG	25
23	XXX	XXX	XXX	XXX	XXX	XXX	XXX	000	000	XXX	HHH	HHH	XXX	XXX	XXX	XXX	HHH	XXX	000	[illegible]

% SIMILARITY

000	XXX	HHH	GGG
0-30	31-50	51-70	71-100

envirosphere company

A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING
MACROINVERTEBRATE SIMILARITIES
BETWEEN ALL PAIRS OF SUBSTRATE
SAMPLERS MID AUGUST-
MID SEPTEMBER 1973

DATE:

EXHIBIT

A-III-C-34

STATION

STATION	2	3	4	5	7	8	9	10	13	14	15	24
2	GGG GGG GGG	78	70	74	51	39	35	63	69	86	61	62
3	GGG GGG GGG	GGG GGG GGG	74	61	44	28	26	61	60	79	49	58
4	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	75	61	41	47	47	56	77	44	60
5	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	65	45	43	48	53	70	39	57
7	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	67	79	38	43	51	39	54
8	XXX XXX XXX	000 000 000	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG	78	24	36	44	36	33
9	XXX XXX XXX	000 000 000	XXX XXX XXX	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	21	33	39	34	51
10	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	000 000 000	000 000 000	GGG GGG GGG	86	64	77	53
13	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	74	82	64
14	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	64	62
15	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	53
24	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG

% SIMILARITY

000 000 000	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

envirosphere company

A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING MACROINVERTEBRATE SIMILARITIES BETWEEN ALL PAIRS OF SUBSTRATE SAMPLERS MID SEPTEMBER - MID OCTOBER, 1973

DATE:

EXHIBIT

A-III-C-35

STATION

STATION	1	2	4	5	6	7	8	9	10	11	13	14	15
1	GGG GGG GGG	54	47	54	46	33	35	24	79	46	76	62	60
2	HHH HHH HHH	GGG GGG GGG	81	81	55	71	61	57	67	84	67	78	72
4	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	79	67	80	62	61	59	78	53	63	61
5	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	73	69	63	53	65	77	64	61	68
6	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	63	63	49	54	65	46	40	50
7	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	78	76	48	79	52	58	61
8	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	84	49	70	55	51	60
9	OOO OOO OOO	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	40	64	47	50	54
10	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	XXX XXX XXX	XXX XXX XXX	GGG GGG GGG	60	78	71	76
11	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	64	71	73
13	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	GGG GGG GGG	HHH HHH HHH	GGG GGG GGG	82	81
14	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	81
15	HHH HHH HHH	GGG GGG GGG	HHH HHH HHH	HHH HHH HHH	XXX XXX XXX	HHH HHH HHH	HHH HHH HHH	HHH HHH HHH	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG	GGG GGG GGG

% SIMILARITY

OOO OOO OOO	XXX XXX XXX	HHH HHH HHH	GGG GGG GGG
0-30	31-50	51-70	71-100

envirosphere company
A DIVISION OF EBASCO SERVICES INCORPORATED

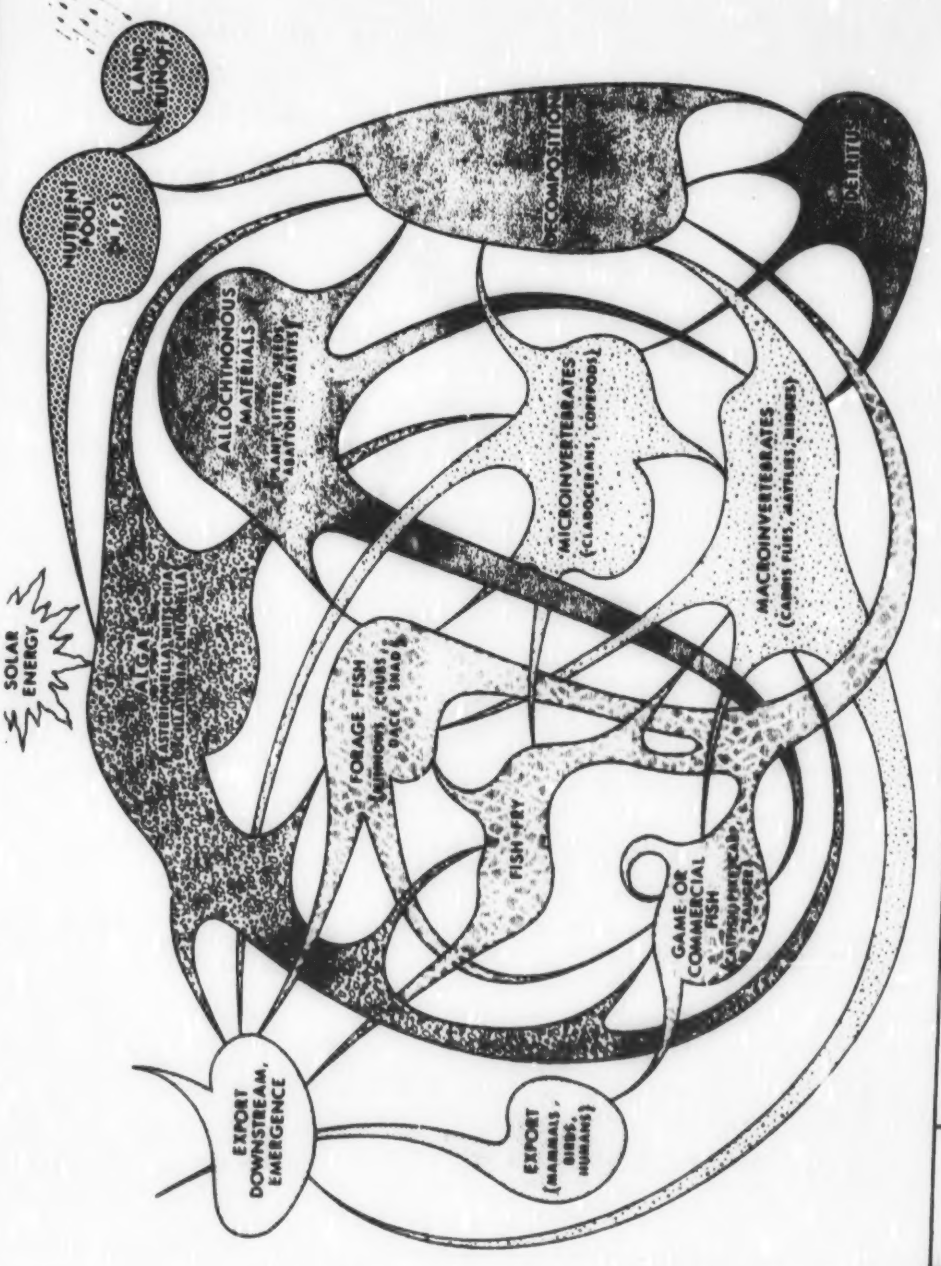
IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TRELLIS DIAGRAM SHOWING MACROINVERTEBRATE SIMILARITIES BETWEEN ALL PAIRS OF SUBSTRATE SAMPLERS MID OCTOBER - MID NOVEMBER, 1973

DATE:

EXHIBIT

A-III-C-36


LAND RUNOFF
NUTRIENT POOL (N,P,C)
SOLAR ENERGY
ALGAE (ASTERIONELLA, NITZCHIA, OSCILLATORIA, CHLORELLA)
ALLOCHTHONOUS MATERIALS (PLANT LITTER, SEEDS, ABATTOIR WASTES)
DECOMPOSITION
DETRITUS
MICROINVERTEBRATES (CLADOCERANS, COPEPODS)
MACROINVERTEBRATES (CADDIS FLIES, MAYFLIES, MIDGES)
FORAGE FISH (MINNOWS, CHUBS, DACE, SHAD)
FISH-FRY
GAME OR COMMERCIAL FISH (CATFISH, PIKE, CARP, SAUGER)
EXPORT DOWNSTREAM, EMERGENCE
EXPORT (MAMMALS, BIRDS, HUMANS)

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

SIMPLIFIED FOOD WEB FOR AQUATIC
ORGANISMS PRESENT IN THE MISSOURI RIVER,
PORT NEAL INDUSTRIAL DISTRICT

DATE:

SCALE:

EXHIBIT
A-III-C-37

The web was developed from the following literature: Bonneau, et al[44], Buckholz[45], Calhoun[46], Carlander[47], Carlson[48], Cramer and Marzolf[43], Cummins[31], Holz[33], Hynes[14], Jester[49], Jude[50], Lagler[51], McComish[52], Minckley, et al[53], Nelson[54], Pennak[55], Platt[56], Russell[1], and Swedberg.[57]

(See Section III-C for References)

Section A-III-C-A

This section contains a detailed discussion of algae in the Missouri River in the vicinity of the George Neal Station. This supplements information provided in Section III-C-2-b of the Environmental Impact Statement.

APPENDIX A-III-C-A

SITE SPECIFIC ECOLOGICAL DATA - ALGAE*

Since there is a scarcity of rooted aquatic macrophytes in channelized sections of the Missouri River, algae, either planktonic or attached (benthic), are the basis of the riverine primary production. Some algae, particularly the truly planktonic (drifting) forms, may be derived from backwater areas, but large rivers like the Missouri can presumably support a true phytoplankton community.[16] True plankton, or euplankton, include the diatoms Asterionella, Fragillaria, Melosira, and Cyclotella, and green algae such as Pandorina, and Pediastrum. Many other algae are benthic: for example, the diatoms - Nitzchia, Navicula, Synedra, Gyrosigma, Gomphonema, Diatoma, Cymbella, and Cocconeis; the blue-greens - Oscillatoria and Lyngbya; and the greens - Ulothrix, Phormidium, and Cladophora. They slough off surface habitats and become part of the plankton, in this case "tychoplankton," or chance plankton. All of the above algae are common in the Missouri and other Midwest rivers.[20,21,22]

Detailed data of abundance and distribution of phytoplankton genera found in the vicinity of the George Neal Station 1-4 from May 1973 through April 1974 and from June 1974 to December 1975, are presented in Appendix Table A-III-C-1. Exhibit III-C-8 represents a consolidation of the data from May 1973 to February 1974.

The data indicate an overwhelming year-round dominance by diatoms. The most abundant genera observed during the study were Asterionella, dominant from January or February through June or July, and Cyclotella, usually dominant from July or August through December or January. However, in the November and December 1975 samples, Asterionella was dominant while in the October 1975 sample Nitzchia was dominant. Both Asterionella and Cyclotella are euplanktonic. Other important diatoms included Fragillaria, Melosira, Nitzchia and Navicula. Nitzchia and Navicula are benthic and were more abundant at Station 4 in spring and summer of 1973 and on June 4, July 2, September 9 and December 3, 1974, and on June 4 of 1975. In May, June and August 1973, abundance of *Nitzchia* at Station 4 was twenty to thirty times greater than anywhere else. *Navicula* showed a similar increase in June 1973. Whether these occurrences reflect the presence of thermophilic species within the two genera, or whether abrasion by the sampling apparatus caused increased sloughing of organisms, has not been conclusively determined. Abundance of other benthic diatoms, (*Diatoma*, *Gomphonema*, *Synedra*) was usually independent of levels of *Navicula* and *Nitzchia*, although *Diatoma* was thirty times more abundant at Station 4 in May, 1973, that it was elsewhere. Kite diagrams showing temporal changes in the relative contribution of *Asterionella*, *Cyclotella*, *Nitzchia*, and *Navicula* to the total sample composition from May 1973 to May 1974. are given in Exhibits III-C-9 to 12.

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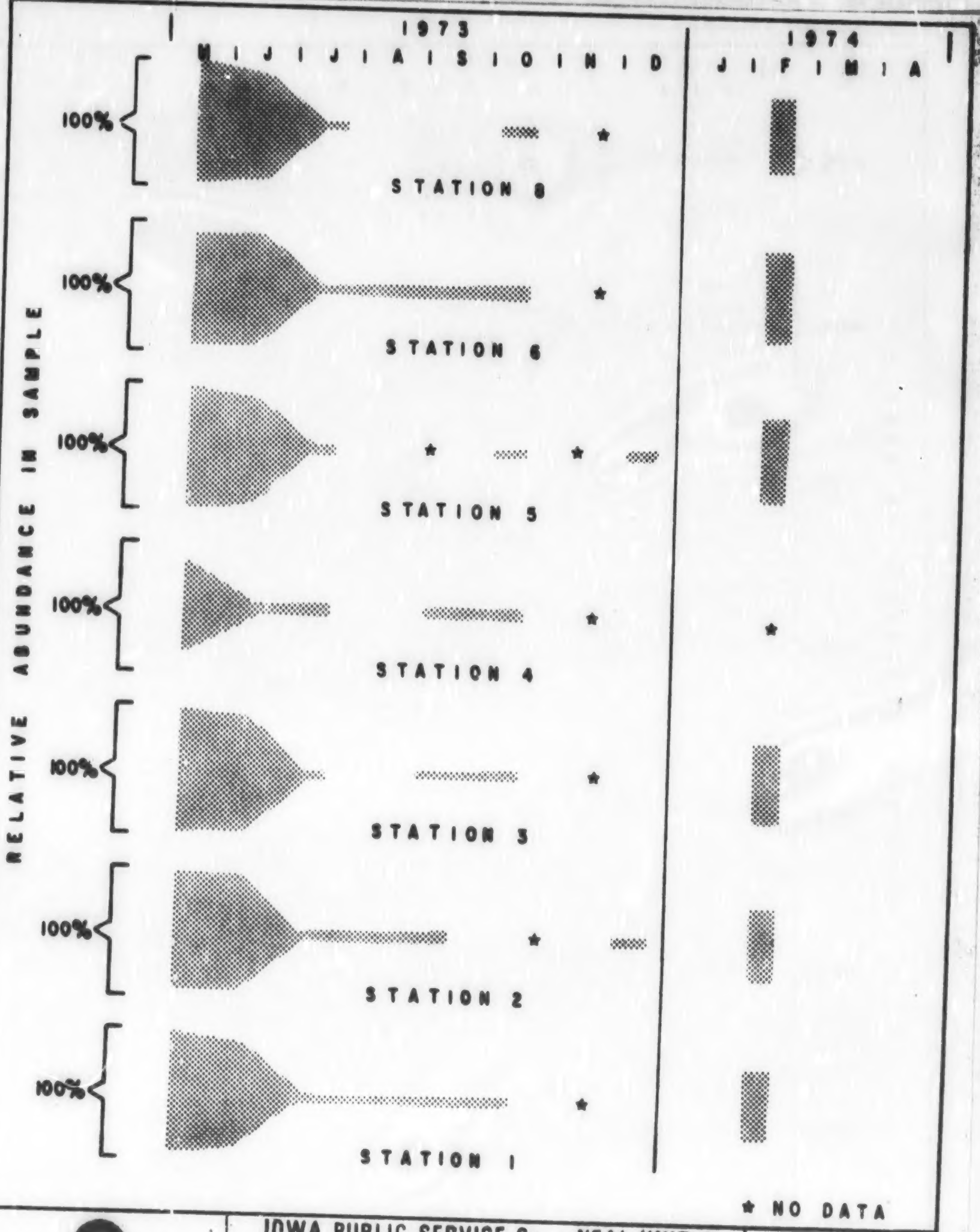
*References for this Appendix are found in Section III-C.

Green algae reached their peak abundances in late summer 1973 and during June 1974 and June 1975. Distribution of green algae was variable (Exhibit III-C-8); sometimes fewer genera (by 1 or 2) occurred at Stations 4 and 5. However, numbers of both genera and individuals were quite low, and were probably within the range of sampling variability.

Blue-green algae were present in low numbers, usually 2000 cells/liter and were generally absent in plankton samples in winter and early spring. Blue-greens, as a group, grow optimally in higher temperatures than green algae diatoms.[23] However, there appeared to be no significant differences in their abundances among the stations sampled, although the May 1973 to May 1974 data showed small increases in blue-green numbers observed at Station 4. Commonly sampled genera of blue-green algae included *Oscillatoria*, *Spirulina*, *Anacystis* and *Stichosiphon*.

Similarities and dissimilarities in the composition of the plankton community among the seven stations are apparent when faunal affinity indices are used. Sanders'[24] index of affinity was used to produce trellis diagrams for each sampling date from May 1973 to April 1974 (Appendix Exhibits A-III-C-1 to 11). This index, as described by Swartz[25], is sensitive to differences in the relative abundance of each species (or in the present case, genus) in the pairs of stations compared. Its value is obtained by first calculating percent composition of the samples, then, taking one pair of stations at a time, summing the smaller percentages for all species. Appendix Exhibits A-III-C-2 and 4 effectively illustrate, with a single number, the sample differences described above. The dominance of samples taken in June at Station 4 by *Navicula* and *Nitzchia*, and of samples taken in August, by *Nitzchia*, is reflected in low similarities between that station and others sampled. Numbers of *Asterionella* and *Cyclotella* which dominated the other samples on a percentage basis, were approximately the same at all stations (with the single exception of *Asterionella* at Station 4, in June 1973).



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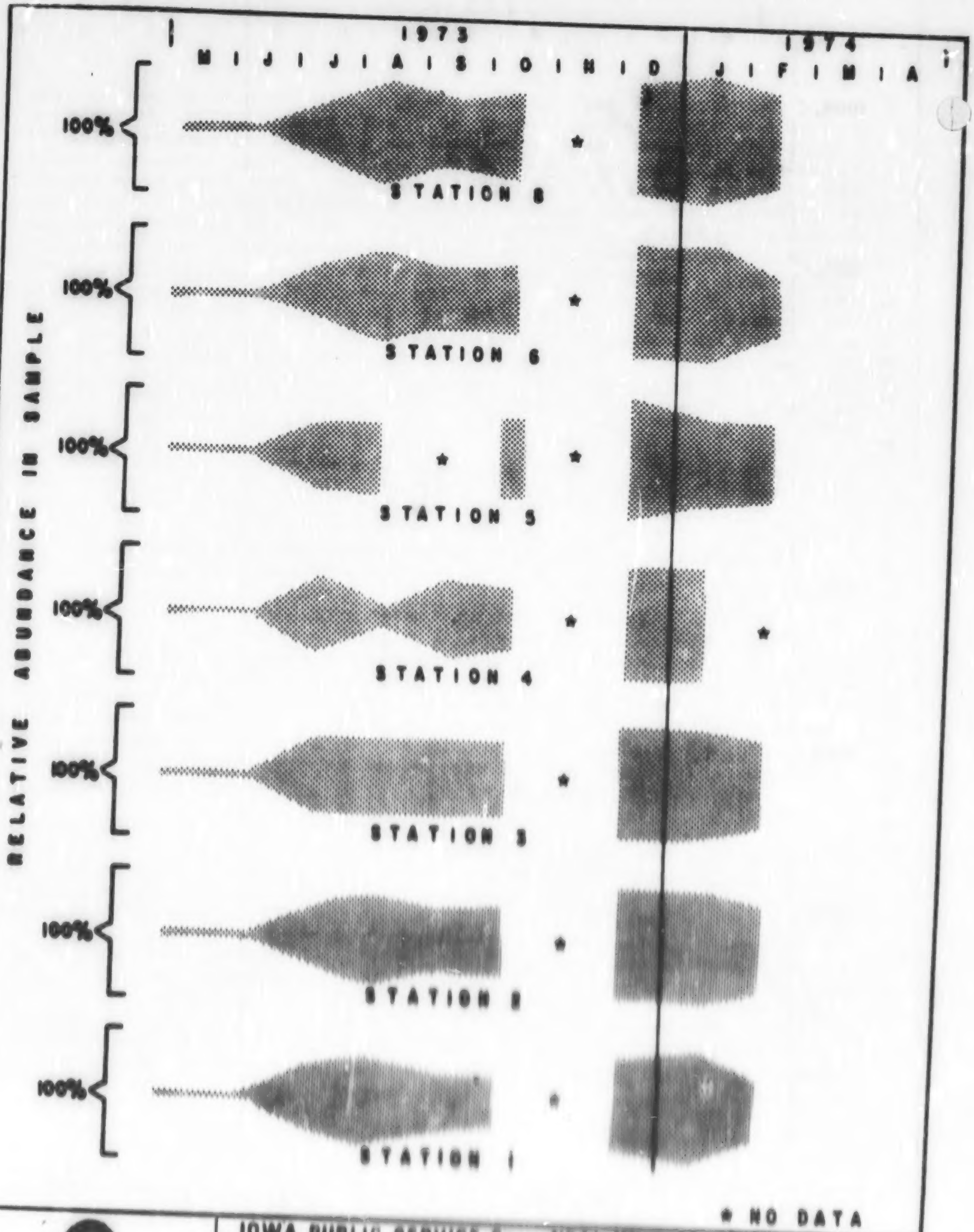
IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

RELATIVE ABUNDANCE OF ASTERIONELLA (PHYLUM CHRYSOPHYTA) AT STATIONS 1-8 MISSOURI RIVER, IOWA

DATE: SCALE:

EXHIBIT
A-III-C-A-1



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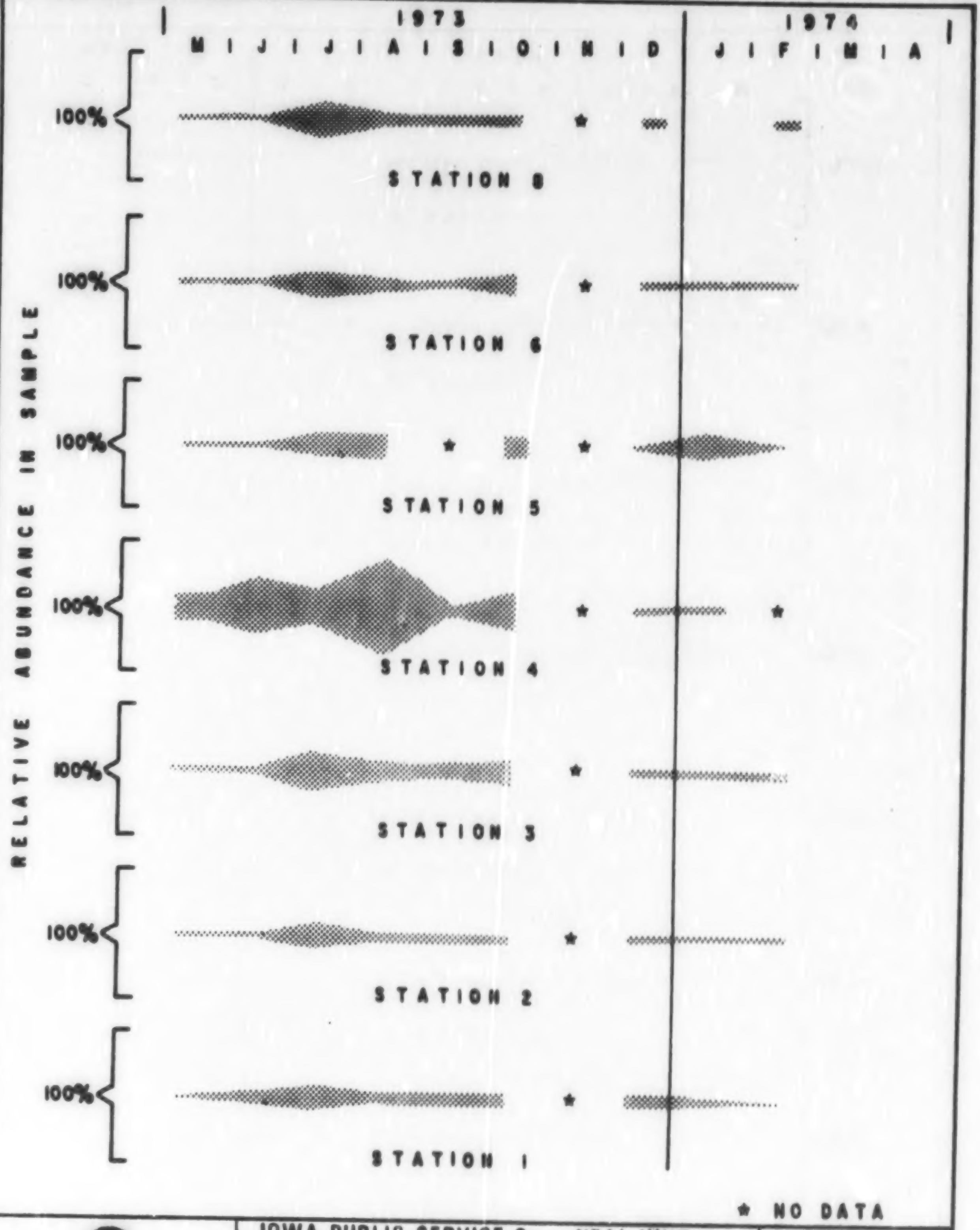
IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

RELATIVE ABUNDANCE OF CYCLOTELLA
(PHYLUM CHRYSOPHYTA) AT STATIONS 1-8
MISSOURI RIVER, IOWA

DATE:
SCALE:

EXHIBIT
A-III-C-A-2



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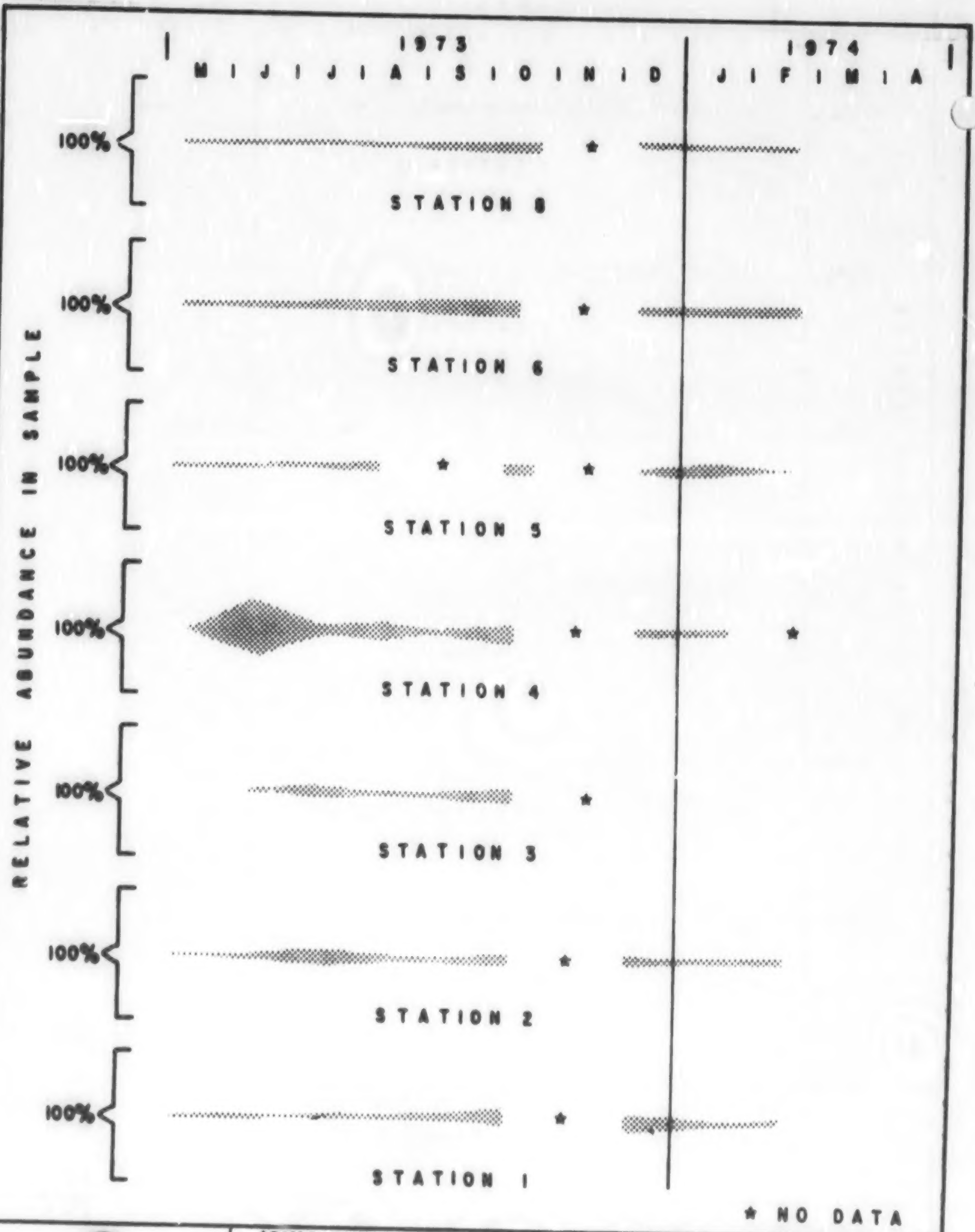
IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

RELATIVE ABUNDANCE OF NITZCHIA
(PHYLUM CHRYSOPHYTA) AT STATIONS 1-8
MISSOURI RIVER, IOWA

DATE:
SCALE:

EXHIBIT
A-III-C-A-3



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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

RELATIVE ABUNDANCE OF NAVICULA
(PHYLUM CHRYSOPHYTA) AT STATIONS 1-8
MISSOURI RIVER, IOWA

DATE: SCALE:

EXHIBIT
A-III-C-A-4

Differences in levels of abundance of key species from May 1973 to February 1974 were also reflected in dendrograms, or tree diagrams depicting station similarities. These are shown in Appendix Exhibits A-III-C-12 to 20, and were formed by regrouping stations on the basis of a general similarity coefficient given by Gower.[24] The coefficient takes into account numerical abundances of genera at each station, and weighs genera equally by dividing levels observed at each station by the range of levels found over all stations. Thus, abundance of genus i is expressed as a fraction of the total range of abundances found over all j stations. Differences in samples taken at Station 4 stand out distinctly in May, June, July, August and October (Appendix Exhibits A-III-C-12 to 15 and 17), when levels of similarity with respect to other stations were between only 0.30 and 0.40 on a scale of 1.00.

Dendrograms based simply on the presence or absence of genera convey yet a different picture (Appendix Exhibits A-III-C-21 to 29). The presence/absence coefficient or Jaccard's coefficient of community (CC),[25] is computed:

$$CC = \frac{C_{ij}}{A_i + A_j - C_{ij}}$$

where: C_{ij} = number of genera common to both samples;

A_i = number of genera in sample i;

and A_j = number of genera in sample j.

It is thus a measure of the fraction of items shared by two samples, and has been used to group plankton samples,[23], [28],[29]. No consistent community patterns emerge in Appendix Exhibits A-III-C-21 to 28; all stations exhibiting similarities generally above 0.50. Station 3 had fewer species in common with other stations in December 1973, and Station 4 had reduced similarity to the rest of the stations in June and July 1973. In June, this was due to a reduction in green algae at Station 4. In July 1973, a blue-green alga (*Lyngbya*) was present at Station 4, and there were subtle differences in diatom composition.

Two qualitative "periphyton" surveys (as they have come to be called) were conducted in the Port Neal area in 1973. In June 1973, rocks were sampled upstream and downstream of Neal Units 1 and 2 discharge. In August 1973, rocks were sampled upstream of, downstream of, and on the discharge structure. Results are given in Tables III-C-5 and 6. Station differences in green algae were essentially opposite on the two sampling dates, and the presence of blue-greens at and below the discharge was noted in August. Genera found were comparable to those reported in the Missouri River near Brownville, Nebraska,[21] where communities colonizing glass panels were generally dominated by *Nitzchia* and *Navicula*.

Periphyton:	Rocks Sampled Downstream of Neal Station Organisms found on percentage of all rocks checked	Rocks Sampled Upstream of Neal Station Organisms found on percentage of all rocks checked
Blue-Green Algae		
Green Algae		
Ankistrodesmus	40	20
Closterium	20	
Pediastrum	20	20
Scenedesmus	20	20
Actinastrum		40
Cladophora	60	100
Stigeoclonium	60	20
Tetrastrum		20
Diatoms		
Asterionella	20	20
Cyclotella		60
Cymbella	100	100
Diatoma	60	100
Fragilaria	100	100
Gomphonema	80	100
Melosira	100	80
Navicula	100	100
Nitzchia	100	100
Stephanodiscus	100	100
Suriella		100
Pleurosigma	40	20
Rotifers	80	
Other		
Hydra		20
Planaria		20
Amoeba		60

Source: Hey and Baldwin 15/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PERIPHYTON SURVEY - JUNE 25, 1973

DATE: SCALE:

TABLE
A-III-C-A-1

Periphyton:	Periphyton on Rocks Sampled Downstream from Neal Station[1]	Periphyton on Outflow Structure[2]	Periphyton on Rocks Sampled Upstream from Neal Station[3]
Blue-Green Algae	X	X	
Oscillatoria	X	X	
Anabaena			X
Green Algae			
Ankistrodesmus			X
Coelastrum	X		
Pediastrum	X		X
Actinastrum	X	X	X
Cladophora	X		
Stigeoclonium		X	
Scenedesmus	X	X	
Diatoms			
Cyclotella			X
Cymbella	X	X	X
Diatoma	X		X
Fragilaria		X	X
Gomphonema	X	X	X
Melosira		X	X
Navicula	X	X	X
Nitzschia	X	X	X
Synedra			X
Rhoicosphenia	X	X	X

Note:

1. There was much more growth on these rocks than on other areas sampled. Cladophora was the primary type found here.
2. The greenish covering was primarily Stigeoclonium and Oscillatoria.
3. There were no significant amounts of greens or blue greens. Most of the rock surfaces were brown and muddy.

X = Presence of Periphyton.

Source: Hey and Baldwin [15]/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PERIPHYTON SURVEY - AUGUST 13, 1973

DATE: SCALE:

TABLE
A-III-C-A-2

Section A-III-E

This section contains a discussion of the air quality and meteorological monitoring programs conducted at the George Neal Station. This supplements information provided in Section III-E of the Environmental Impact Statement.

APPENDIX A-III-E

AIR QUALITY AND METEOROLOGICAL MONITORING SYSTEMS

A. AIR QUALITY MONITORING SYSTEM

1. Ambient Air Quality

a. Introduction

An ambient air quality monitoring system (AQMS) was installed in the area surrounding the Neal Station and began operation in 1975. The pollutants that are being monitored continuously are the three major contaminants emitted from coal-fired electric generating plants: sulfur dioxide (SO2), nitrogen oxides (NOx), and suspended particulate matter.

Though continuous air quality monitoring is not required by either Federal or State regulations, IPS is embarking on this program for the following reasons:

- Monitoring will show the status of any air pollution episode that has been declared for the area by the Iowa Air Quality Commission.
- Baseline air quality data is being obtained in the vicinity of the Neal Station.
- The accuracy of the model calculations of ground level contaminant concentrations can be verified and refined.

The air quality monitoring program described below was pursued in consultation with the Iowa Department of Environmental Quality. This ensured compatibility with the Department's air pollutant sampling program, enabled IPS to build an AQMS based on the Department's and other utilities' experience with air quality monitoring equipment and achieved more effectively the aforementioned monitoring goals of IPS. Based upon the information learned from the AQMS after an appropriate operating period, certain system modifications may be indicated. If necessary, additions, deletions or substitutions of locations and/or instrumentation may take place.

b. Description of the AQMS

The AQMS consists of four trailers, each equipped with the following instrumentation: flame photometric or coulometric sulfur dioxide analyzer, chemiluminescent nitrogen oxides analyzer, high-volume sampler, tape sampler and dustfall bucket.

The flame photometric sulfur dioxide analyzer detects specific wavelengths of light emitted when sulfur compounds are burned in a hydrogen flame. A particulate filter and a hydrogen sulfide scrubber remove possible interferents before they reach the analyzer.

Operation of the coulometric sulfur dioxide analyzer is based on measurement of the reduction/oxidation potential originating from the electrolytic generation of free bromine in an aqueous solution of potassium bromide, bromine and sulfuric acid when air containing sulfur dioxide is passed through the solution.

The chemiluminescent nitrogen oxides (NOx) analyzer measures, in separate channels, concentrations of oxides of nitrogen (which have been converted to nitric oxide) and nitric oxide (NO). The nitrogen dioxide (NO2) concentration is obtained from the difference of NOx and NO concentrations. Chemiluminescent light detection occurring when ozone reacts with NO forms the basis for operation of this instrument. A particulate filter screens out possible interferents. Ammonia is not an interferent since it is not converted to NO within the analyzer.

The high volume sampler enables measurement of 24-hour concentrations of particulate matter. The air sample is drawn through a filter paper continuously and at a known rate during the sampling period. At the end of this period the increase in weight of the filter paper is used to calculate the ambient particulate matter level.

The tape sampler measures light transmittance through a spot on a filter after an air sample has been drawn through it at a fixed rate and for a known time interval. This instrument is used to measure the soiling index of ambient air. The unit of measurement is the coefficient of haze per 1000 linear feet (COH/1000 ft) of sampled air.

Settleable particulates are measured using a dustfall bucket placed on top of the trailer. The sampling period is 30 days, after which the contents are weighed.

Automatic digital and analog recording devices maintain a continuous historical record of SO2 concentrations, NO2 concentrations and particulate matter soiling potential. Particulate matter concentrations and dustfall are measured manually, periodically.

The AQMS is checked on a weekly basis. The sulfur dioxide analyzer and chemiluminescent nitrogen oxides analyzer are calibrated each week. The remainder of the instrumentation is calibrated as required based on the weekly inspection.

c. Monitoring Station Siting

Prior to the selection of the present monitoring station sites, a Gaussian dispersion model similar to that described in Section IV-C-1 was utilized to identify ground level points of expected maximum short and long-term concentrations. The locations of the monitoring sites are described in Table A-III-E-1 and shown on a map in Exhibit A-III-E-1.

1. North Site (#1)

   a 40' x 40' tract of land in the SW ¼ NW ¼ of Section 13, Township 87 North, Range 48 West of the 5th P.M. Woodbury County, Iowa.

2. Terra Sites (#2 & #3)

   Site #2 - A 40' x 40' tract of land in the SW ¼ of Section 24, Township 87 North, Range 48 West of the 5th P.M., Woodbury County, Iowa.

   Site #3 - A 40' x 40' tract of land in the SE ¼ of Section 24, Township 87 North, Range 48 West of the 5th P.M., Woodbury County, Iowa.

3. Nebraska Site (#4)

   A 40' x 40' tract of land in the SE corner of Section 20, Township 27 North, Range 9 East of the 6th P.M., Dakota County, Nebraska. (Primary Site)

4. South Site (#5)

   A tract of land, 40' x 40', in the SW ¼ of Section 32, Township 87 North, Range 47 West of the 5th P.M., Woodbury County, Iowa.

5. Meteorological Tower

   A tract of land in the NW ¼ of Section 30, Township 87 North, Range 47 West of the 5th P.M., Woodbury County, Iowa.

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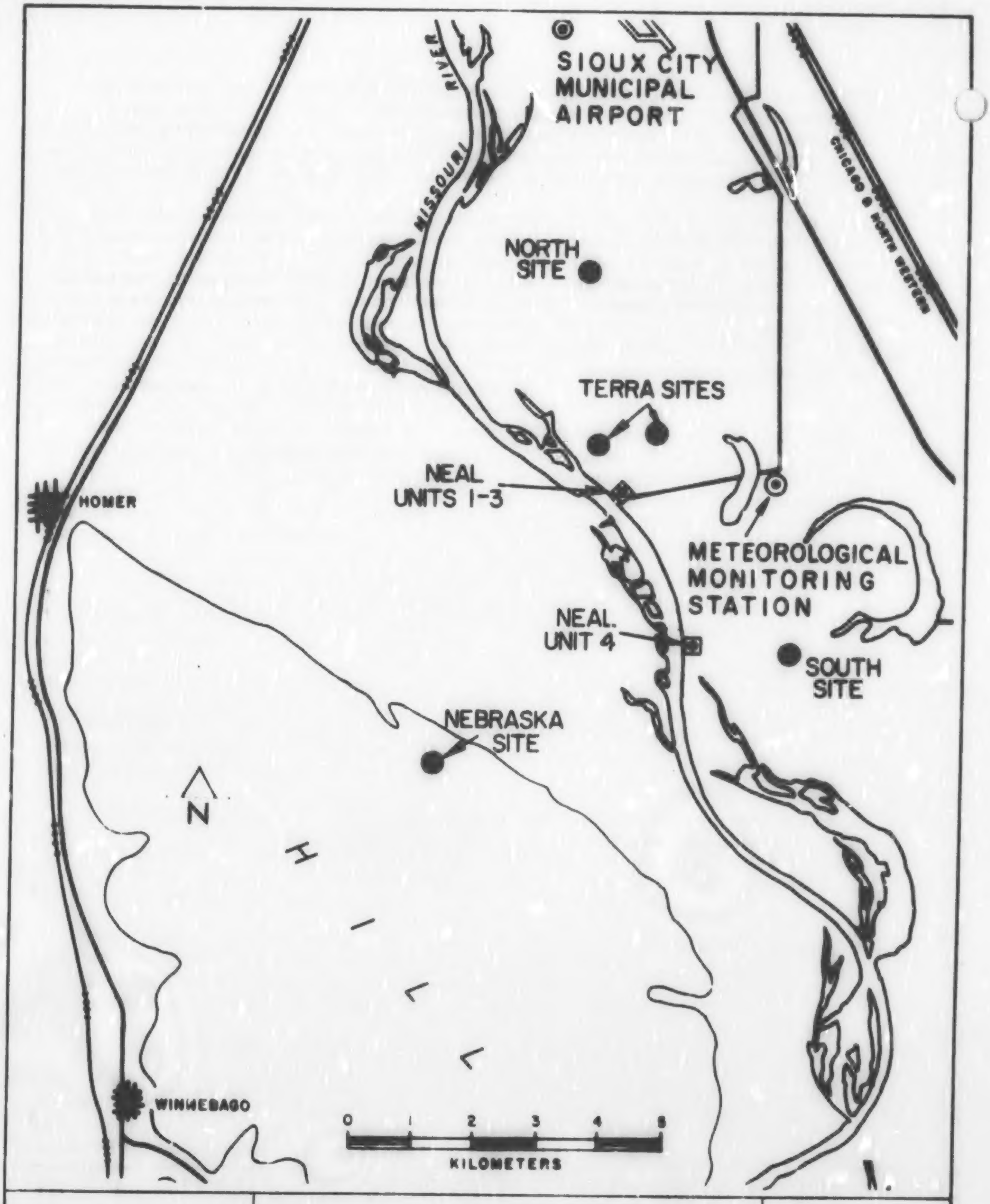
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

AIR QUALITY MONITORING SYSTEM - SITE LOCATIONS

DATE: SCALE:

TABLE

A-III-E-1


SIOUX CITY MUNICIPAL AIRPORT
MISSOURI RIVER
CHICAGO & NORTH WESTERN
NORTH SITE
TERRA SITES
NEAL UNITS 1-3
METEOROLOGICAL MONITORING STATION
HOMER
NEAL. UNIT 4
SOUTH SITE
NEBRASKA SITE
N
HILL
WINNEBAGO
0 1 2 3 4 5
KILOMETERS

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AIR QUALITY AND METEOROLOGICAL MONITORING STATIONS

EXHIBIT A-III-E-1

DATE:

SCALE:

Based on an evaluation of the air quality data obtained thus far, and in consideration of the results of the dispersion model analysis described in Section IV-C-1, the monitoring stations will be relocated, if necessary, to insure that the maximum ground level concentrations due to the operation of the Neal Station will be recorded.

2. Emission Monitoring

The New Source Performance Standards through revisions effective October 6, 1975, require the installation of an emission monitoring system for new fossil fuel-fired steam generators. For coal-fired facilities, the following parameters must be continuously monitored:

- Stack plume opacity.
- Sulfur dioxide (except that when compliance with the New Source Performance Standard for SO2 is to be achieved solely by the utilization of low sulfur coal, fuel analyses may be employed in lieu of monitoring).
- Nitrogen oxides (except when performance tests show that the boiler design results in emissions at least 30 percent below the New Source Performance Standard for NOx).
- Oxygen or carbon dioxide (so that measured SO2 and NOx concentrations can be accurately converted from units of parts per million to a pounds per million Btu basis, facilitating the comparison of emission rates to the New Source Performance Standards).

The performance specifications for the Neal Unit 4 stack gas monitoring system are summarized in Table A-III-E-2.

		Opacity	SO_2	NO_x	O_2 or CO_2
Span		80, 90 or 100%	1500 ppm	500 ppm	-
Accuracy		20%(a)	20%(b)	20%(b)	-
Calibration Error		3%	5%(c)	5%(c)	
Zero Drift -	2 hr	-	2%(d)	2%(d)	0.4%
	24 hr	2%	2%(d)	2%(d)	0.5%
Calibration Drift -	2 hr	-	2%(d)	2%(d)	0.4%
	24 hr	2%	2.5%(d)	2.5%(d)	0.5%
Response Time		10 sec	15 min	15 min	10 min
Cycle Period		10 sec	15 min	15 min	15 min
Operational Period		168 hr	168 hr	168 hr	168 hr

Notes:

(a) Percent of test filter value
(b) Percent of reference method mean value
(c) Percent of calibration gas mixture value
(d) Percent of span

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

STACK GAS MONITORING SYSTEM SPECIFICATIONS

DATE: SCALE:

TABLE
A-III-E-2

B. METEOROLOGICAL MONITORING SYSTEM

Diffusion calculations and the climatology for the Neal Station have been generally based on meteorological data at the Sioux City Municipal Airport. The airport is located above five miles north of Units 1-3 and seven miles north of Unit 4. Climatic conditions at the airport are considered representative of the site area as there are no significant differences in topography, elevation and physical features.

Specific ground level weather parameters, however, can vary between the airport and site. The airport is closer to urban (Sioux City) influences which may affect the temperature, humidity, visibility, radiation, wind and precipitation. Conversely, the site is about four miles closer to the higher terrain west of the Missouri River; this may cause dissimilar airflow patterns due to a greater prevalence of upslope and downslope winds at the site.

Diffusion patterns are highly dependent on the vertical stability of the atmosphere. Predictions of stability conditions have been based upon the Turner Method; ground level observations of solar elevation angles, cloud conditions and wind speeds are correlated with the vertical temperature lapse rates. The wind speeds at stack-top elevations are derived from near-surface observation heights using a stability-dependent power law relationship.

The use of on-site meteorological monitoring in conjunction with the airport climatic data will yield an accurate determination of local topographical effects and micrometeorological conditions at the site. Furthermore, the continuous measurement of vertical temperature and windspeed gradients over a 164 foot height range will provide a more representative on-site stability profile.

The monitoring system consists of three levels of instrumentation mounted on a guyed 199-foot tower, a building containing digital and analog recording systems, a backup power supply and required peripheral equipment. The entire system is contained within a fenced enclosure. Meteorological variables measured on the tower are: ambient temperature, dewpoint, wind speed and wind direction, and vertical temperature differences. A precipitation gauge is installed at ground level near the base of the tower.

The monitoring station is located about five miles south of the Sioux City Municipal Airport at an elevation of about 1087 feet above mean sea level. It is about one and one-quarter miles east of Units 1-3 and approximately two miles north-northeast of proposed Unit 4 (See Exhibit A-III-E-1). Weather parameters measured at the monitoring station are representative of conditions at all units since the tower is located near both site areas.

The following sensors are located at the on-site monitoring station:

1. Ambient Temperature

An ambient temperature sensor is mounted at the 30 foot level. It provides an instantaneous measurement once a minute. The operating range is -30°C to 50°C with an accuracy of ±0.5°C.

2. Dewpoint

A dewpoint sensor is mounted at the 30 foot level. It provides instantaneous measurements once a minute. The operating range is -30°C to 50°C dewpoint. Accuracy is ±1°C.

3. Wind Speed and Direction

Wind speed and wind direction sensors are mounted at the 30 and 194 foot levels. They provide time-weighted average measurements once each minute. Both the anemometers and potentiometric wind vanes have an operating range of 0-100 miles per hour and a threshold of 0.75 mile per hour or less. Accuracy of the anemometers is the greater of ±1 percent or ±0.15 miles per hour. The wind vanes have accuracies of ±5 degrees.

4. Vertical Temperature Difference

One temperature difference measurement is made between 194 and 112 feet and another between 112 and 30 feet. The sensors are capable of measuring vertical temperature differences ranging from -5° to +10°C with an accuracy of ±0.1°C.

5. Precipitation Gauge

A heated tipping bucket rain/snow gauge is located near the base of the tower. It provides one minute total ground level precipitation measurements and has an accuracy of ±0.5 percent.

Section A-III-H

This section presents tables containing data relating to the socioeconomic characteristics of the Neal Unit 4. This supplements information provided in Section III-H of the Environmental Impact Statement.

	Woodbury Co. (Iowa)	Monona Co. (Iowa)	Dakota Co. (Neb)	Thurston Co. (Neb)
Number of Farms	1,970	1,267	454	662
Acres of Farms	516,345	407,509	143,292	215,146
Average Size of Farm	262.1	321.6	315.6	324.9
Value of Farms*:				
Thousands of Dollars	267,458	203,553	57,815	87,679
Average Per Farm ($)	135,766	160,658	127,345	132,446
Average Per Acre ($)	518	500	403	408
Value of Farm Products Sold:				
Thousands of Dollars*	116,550	50,918	18,548	34,994
Percent Crops & Forest Products	16.6	42.6	29.1	15.2
Percent Livestock & Poultry	83.4	57.4	70.9	84.8
Number of Farms by Value of Products Sold.*				
Less than $3,875	278	112	71	72
$3,875 to $14,499	491	302	127	148
$15,500 to $61,999	814	649	189	312
$62,000 and Over	387	204	67	130
Percentage.				
Total Acreage of Farmland	100.0	100.0	100.0	100.0
Cropland - Total	84.5	82.0	81.9	85.4
Harvested Cropland	55.1	55.8	54.1	55.4
Cropland for Grazing	12.3	9.2	9.6	9.4
Other Cropland	17.1	17.0	18.2	20.6
Woodland	2.8	5.6	4.1	2.4
All Other Farmland	12.6	12.5	13.9	12.2

*Note: 1969 Economic Data Converted to 1974 Dollars.
Conversion values measured by Wholesale Price Index for Farm Products.
June, 1974, Bureau of Labor Statistics.

Source: U S Bureau of the Census, 1969 Census of Agriculture parts 6 and 20, Section 2

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

SIGNIFICANT CHARACTERISTICS OF
THE AREA'S AGRICULTURE

TABLE
A-III-H-1

DATE: SCALE:

Farms by Activities and Principal Activity Type

	Farms Reporting	% of All Farms	Principle Activity Type	% of All Farms
Crops Produced for Sale:	1,425	83.8	466	27.4
Cash Grain Crops	1,360	80.0	462	27.2
Other Field Crops	73	4.3	3	0.2
Vegetables	5	0.3	1	0.1
Fruit, Nuts and Berries	7	0.4		
Livestock & Poultry	1,444	84.9	1.179	69.3
Dairy & Products:	211	12.4	32	1.9
Poultry & Products	219	12.9	12	0.7
Other Livestock	1.163	68.4	1,135	66.7
Forest Products	14	0.8		
General			47	2.8
Miscellaneous			9	0.5
Total			1,701	100.0

Farms And Uses By Size Of Farm

	All Farms		Farms with Harvested Cropland		
	Number	Acres in Farms	Number	Total Acres in Farms	Acres of Harvested Cropland
Total	1,701	499,618	1,598	493,132	280,741
Farms With					
1-9 Acres	46	96	2	9	4
10-49 Acres	73	2,247	41	1,254	795
50-69 Acres	24	1,406	19	1,120	730
70-99 Acres	108	8,735	103	8,328	4,562
100-139 Acres	100	11,777	96	11,299	5,739
140-179 Acres	265	42,000	262	41,546	24,146
180-219 Acres	136	26,854	135	26,654	14,641
220-259 Acres	189	45,042	186	44,290	26,359
260-499 Acres	550	196,543	546	195,114	114,614
500-999 Acres	181	116,391	179	114,991	65,669
1,000-1,999 Acres	25	33,122	25	33,122	15,125
2,000 Acres and Over	4	15,405	4	15,405	8,357

Source: U S Bureau of the Census, 1969 Census of Agriculture,
Part 16, Section 1, Table 6; Section 2, Tables 10 and 13.

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FARMS BY TYPE AND SIZE OF FARM, WOODBURY COUNTY (FARMS WITH SALES OF $2 500 AND MORE)

DATE: SCALE:

TABLE A-III-H-2

	Woodbury Co. (Iowa)	Monoka Co. (Iowa)	Dakota Co. (Neb)	Thurston Co. (Neb)
Manufacturing Firms	132	7	23	8
Wholesale Establishments	268	27	17	10
Retail Stores	630	115	88	52
Eating & Drinking Places	174	28	25	12
Automotive Dealers & Service Stations	128	17	17	2
Building Material & Farm Equipment	44	18	D	D
Food Stores	69	18	11	D
Other Retail Stores	215	34	D	D
Contract Construction	162	14	25	5
Mining Establishments	1	1		
Argricultural Services, Fisheries, Forestry,	16	1	7	2
Transportation & Public Utilities	130	22	14	3
Finance, Insurance & Real Estate	227	16	18	4
Services	630	60	61	19
Personal Services	100	14	D	D
Medical & Health Services	126	10	9	5
Non-Profit Organizations	125	D	11	7
Other Services	279	D	D	D
Unclassified Establishments	18		2	2
Total Establishments	2,214	263	255	105
Total Taxable Payrolls, January-March ($1,000)	51,077	1,349	7,269	1,241

D = Data not available separately within a major category where sub-classification has less than 100 employees or 10 reporting units.

Source: U S Department of Commerce,
County Business Patterns, 1972

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[illegible]

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

NUMBER OF BUSINESS ESTABLISHMENTS
BY TYPE, FOUR COUNTY REGION, 1972

DATE:
SCALE:

TABLE A-III-H-3

Business Establishments by Payroll Data:
Woodbury County

	Payrolls Jan-Mar ($1000)	Number of Establishments	Number of Employees	Percent of Total Payrolls
Manufacturing Firms	15.543	132	8.121	30.4
Wholesale Establishments	5.453	268	2.960	10.7
Retail Stores	8.158	630	7,710	16.0
Contract Construction	4,685	162	1.918	9.2
Mining	(W)	1	(W)	(W)
Agricultural Services. Forestry	57	16	57	0.1
Transportation & Public Utilities	5.601	130	2,736	11.0
Finance. Insurance & Real Estate	3.856	227	2.197	7.5
Services	7.590	630	6,723	14.9
Unclassified Establishments	(W)	18	(W)	(W)
Total Establishments	51.077	2.214	32.533	100.0

Business Establishments
By Number Of Employees. Woodbury County

	1-3	4-7	8-19	20-49	50-249	250 or More
Manufacturing Firms	24	20	27	23	29	9
Wholesale Establishments	68	63	96	36	5	-
Retail Stores	266	142	122	74	25	1
Contract Construction	74	19	36	28	5	
Mining		1		-		-
Agriculture Services. Forestry	10	5	1	–	-	
Transportation & Public Utilities	49	24	34	13	8	2
Finance. Insurance & Real Estate	130	39	38	11	9	
Services	332	134	108	40	13	3
Unclassified Establishments	10	3	4	1	--	-
Total Establishments	963	450	466	226	94	15

W = Data Withheld to Avoid Individual Disclosures.

Source: U S Department of Commerce. County Business Patterns. 1972.

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TYPES OF BUSINESS ESTABLISHMENTS BY PAYROLLS AND NUMBER OF EMPLOYEES

DATE:
SCALE:

TABLE A-III-H-4

Section A-IV-B

This section presents tables containing aquatic monitoring field data obtained during the course of the program conducted at the George Neal Station. This information is separated from those data presented in Section A-III-C because it supplements information provided in Section IV-B of the Environmental Impact Statement.

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Transect 1, Iowa

	Replicate 1 Slide 1	Replicate 1 Slide 2	Replicate 1 Slide 3
Blue-Green Algae			
Anacystic	1	1	1
Green Algae			
Ankistrodesmus	1		1
Chlorella			2
Pandorina			1
Pediastrum		2	1
Scenedesmus	4	5	4
Ulothrix	2	1	
Actinastrum	9	7	11
Total	16	15	20
Diatoms			
Asterionella	383	620	495
Cyclotella		3	10
Diatoma			3
Fragilaria	1	4	4
Gyrosigma			3
Melosira			1
Navicula			5
Nitzschia	4	3	50
Stephanodiscus	3	1	1
Synedra	3	1	2
Tabellaria	—	17	1
Total	394	649	575

	Replicate 2 Slide 1	Replicate 2 Slide 2	Replicate 2 Slide 3
Blue-Green Algae			
Anacystic		1	4
Green Algae			
Ankistrodesmus		4	3
Chlorella		2	
Pediastrum	1	2	2
Scenedesmus	3	7	5
Ulothrix			3
Actinastrum	1	10	13
Total	4	25	26
Diatoms			
Asterionella	377	409	475
Cyclotella	1	8	10
Diatoma		1	
Fragilaria	1	2	1
Gyrosigma		2	1
Navicula	1	4	3
Nitzschia	1	39	41
Stauroneis			1
Stephanodiscus		2	
Synedra	3	1	5
Tabellaria	—	6	1
Total	384	474	538

	Replicate 3 Slide 1	Replicate 3 Slide 2	Replicate 3 Slide 3
Blue-Green Alge			
Anacystis			1
Green Algae			
Ankistrodesmus	1		4
Pediastrum			3
Scenedesmus	1	2	
Ulothrix			2
Actinastrum	1	11	9
Total	3	13	18
Diatoms			
Asterionella	351	383	481
Cyclotella			9
Diatoma		1	
Fragilaria	3	1	3
Navicula			2
Nitzschia			35
Synedra	—	3	6
Total	354	388	537

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
SPECIAL PLANKTON DISTRIBUTION STUDY
MAY 30, 1974
(SHEET 1 OF 7 SHEETS)

DATE:

SCALE:

TABLE
A-IV-B-1

Transect 1, Mid-River

	Replicate 1 Slide 1	 2	 3
Blue-Green Algae			
Anacystis	1		
Green Algae			
Ankistrodesmus			10
Pediastrum			3
Scenedesmus		1	1
Ulothrix			3
Actinastrum	2	1	16
Total	2	2	33
Diatoms			
Asterionella	471	432	708
Cyclotella		3	6
Diatoma			1
Fragilaria	1	2	3
Gyrosigma			2
Navicula			3
Nitzschia	3	1	65
Synedra	2	5	9
Tabellaria		1	
Total	477	444	797

	Replicate 2 Slide 1	 2	 3
Blue-Green Algae			
Anacystis		2	
Green Algae			
Ankistrodesmus		5	2
Pediastrum	1	2	
Scenedesmus	3	1	2
Ulothrix			2
Actinastrum	2	10	7
	6	18	13
Diatoms			
Asterionella	338	661	556
Cyclotella	2	4	11
Diatoma		3	1
Fragilaria	3	2	2
Gyrosigma		1	7
Navicula			2
Nitzschia	1	29	21
Stephanodiscus	1	1	1
Synedra		10	11
Tabellaria		1	1
Total	345	712	613

	Replicate 3 Slide 1	 2	 3
Blue-Green Algae			
Anacystis	1	3	1
Oscillatoria			1
Anabaena	1	1	
Green Algae			
Ankistrodesmus	8	9	9
Pediastrum	5	3	2
Scenedesmus	4	4	2
Ulothrix	1		
Actinastrum	19	23	36
	37	39	36.
Diatoms			
Asterionella	510	501	443
Cyclotella	17	21	22
Diatoma	1	1	
Fragilaria	8	3	2
Gyrosigma	1		2
Melosira	2		1
Navicula	3		3
Nitzschia	54	78	74
Stauroneis			1
Synedra	5	2	16
Tabellaria		1	1
Total	601	607	565

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
SPECIAL PLANKTON DISTRIBUTION STUDY
MAY 30, 1974
(SHEET 2 OF 7 SHEETS)

DATE:

SCALE:

TABLE
A-IV-B-1
(Cont'd)

Transect 1. Nebraska

	Replicate 1 Slide 1	Replicate 1 Slide 2	Replicate 1 Slide 3
Blue-Green Algae			
Anacystis	2		
Green Algae			
Ankistrodesmus			1
Pediastrum	1		
Scenedesmus	1		1
Ulothrix	1	3	1
Actinastrum	1	2	7
Total	4	5	10
Diatoms			
Asterionella	628	572	766
Cyclotella	9	7	11
Fragilaria	5	3	6
Gyrosigma	4	1	1
Nitzschia	3	6	12
Synedra	7	8	5
Tabellaria	1	1	
Total	657	598	801

	Replicate 2 Slide 1	Replicate 2 Slide 2	Replicate 2 Slide 3
Blue-Green Algae			
Green Algae			
Ankistrodesmus		1	
Ulothrix	2		2
Actinastrum		1	1
Total	2	2	3
Diatoms			
Asterionella	626	569	721
Cyclotella	2	8	4
Cymbella	1		1
Fragilaria	1	3	
Gyrosigma	3		1
Navicula	1	1	1
Nitzschia	9	2	10
Stephanodiscus			1
Synedra	8	10	6
Tabellaria	2		
Total	653	593	745

	Replicate 3 Slide 1	Replicate 3 Slide 2	Replicate 3 Slide 3
Blue-Green Algae			
Green Algae			
Ankistrodesmus	1		
Scenedesmus		1	4
Ulothrix	1		
Actinastrum	1		2
Total	3	1	6
Diatoms			
Asterionella	670	627	449
Cyclotella	5	3	1
Fragilaria	6	3	3
Gyrosigma	2	2	
Navicula	1	1	
Nitzschia	13	12	
Stephanodiscus			1
Suriells	1	3	
Synedra	8	10	5
Pleurosigma		1	
Tabellaria			1
Total	706	662	460

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
SPECIAL PLANKTON DISTRIBUTION STUDY
MAY 30, 1974
(SHEET 3 OF 7 SHEETS)

DATE:
SCALE:

TABLE
A-IV-B-1
(Cont'd)

Transect 6, Iowa

Replicate 1 Slide	1	2	3
Blue-Green Alge			
Anacystis		1	1
Oscillatoria	1		
Green Algae			
Ankistrodesmus	1	2	
Pediastrum	1	1	
Scenedesmus	1		
Ulothrix	1		1
Actinastrum	6	5	2
Total	10	8	3
Diatoms			
Asterionella	595	671	437
Caloneis			1
Cyclotella	4	3	1
Diatoma	3		2
Fragilaria	3		2
Gyrosigma	2	2	
Melosira		1	
Navicula	4	2	
Nitzschia	26	29	1
Stephanodiscus	1		
Synedra	8	8	2
Tabellaria		1	2
Total	646	717	448

Replicate 2 Slide	1	2	3
Blue-Green Algae			
Green Algae			
Ankistrodesmus	4		2
Pediastrum	3	1	3
Scenedesmus		1	1
Ulothrix		1	1
Actinastrum	2	2	3
Total	9	5	10
Diatoms			
Asterionella	468	558	630
Cyclotella	2		10
Diatoma			1
Fragilaria	1		1
Gyrosigma			2
Nitzschia	4	2	16
Stephanodiscus	1	1	1
Synedra	3	7	10
Tabellaria		2	2
Total	479	570	673

Replicate 3 Slide	1	2	3
Blue-Green Algae			
Anacystis	1		
Oscillatoria	1	1	
Green Algae			
Ankistrodesmus	2	2	4
Scenedesmus		1	1
Ulothrix		3	
Actinastrum	6	3	4
Total	8	9	9
Diatoms			
Asterionella	600	614	557
Cyclotella	3	4	10
Fragilaria	3	2	3
Gyrosigma	1	2	1
Navicula			1
Nitzschia	18	23	24
Stephanodiscus		2	1
Synedra		10	7
Tabellaria	1	1	2
Total	626	658	606

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
SPECIAL PLANKTON DISTRIBUTION STUDY
MAY 30, 1974
(SHEET 4 OF 7 SHEETS)

DATE:
SCALE:

TABLE
A-IV-B-1
(Cont'd)

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Transect 6, Mid-River

Replicate 1 Slide	1	2	3
Blue-Green Algae			
Anacystis			1
Oscillatoria		1	
Green Algae			
Pediastrum	1		
Scenedesmus		1	
Actinastrum	2		
Endorina		1	
Total	3	2	0
Diatoms			
Asterionella	586	470	635
Cyclotella	2	1	6
Diatoma	1		
Fragilaria	8	2	4
Nitzschia	2	2	7
Stephanodiscus			1
Synedra	1	1	9
Total	600	476	662

Replicate 2 Slide	1	2	3
Blue-Green Algae			
Anacystis	1	1	
Green Algae			
Ankistrodesmus	3		1
Pediastrum	1	1	
Scenedesmus			3
Ulothrix	1		
Actinastrum	1		2
Total	6	1	6
Diatoms			
Asterionella	724	729	574
Cyclotella	8	4	2
Diatoma	2		1
Fragilaria	5	2	4
Gyrosigma	3	1	
Melosira		1	
Navicula	1		
Nitzschia	10	11	8
Stephanodiscus	2	1	3
Synedra	9	10	2
Tabellaria	1	1	1
Total	766	760	595

Replicate 3 Slide	1	2	3
Blue-Green Algae			
Green Algae			
Ankistrodesmus	1		5
Pediastrum		2	
Scenedesmus		1	
Ulothrix	1		2
Actinastrum			1
Endorina	2	1	
Micractinium			1
Total	4	4	9
Diatoms			
Asterionella	507	515	513
Cyclotella		2	1
Diatoma			1
Fragilaria	2	6	4
Nitzschia	2	1	5
Stephanodiscus	4	4	
Suriella	1		
Synedra	3	3	6
Total	519	531	530

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
SPECIAL PLANKTON DISTRIBUTION STUDY
MAY 30, 1974.
(SHEET 5 OF 7 SHEETS)

DATE:
SCALE:

TABLE
A-IV-B-1
(Cont'd)

Transect 6, Nebraska

	Replicate 1 Slide 1	Replicate 1 Slide 2	Replicate 1 Slide 3
Blue-Green Algae			
Oscillatoria		1	
Green Algae			
Ankistrodesmus	1	1	1
Coelastrum			1
Pediastrum	1		1
Scenedesmus			1
Ulothrix		1	
Actinastrum	1		
Total	3	2	4
Diatoms			
Asterionella	483	504	568
Cyclotella	2	3	1
Fragilaria	3	1	2
Navicula	2		
Nitzschia	2	4	5
Stephanodiscus	1	1	2
Suriella			1
Synedra	4	3	4
Tabellaria		1	1
Total	497	517	584

	Replicate 2 Slide 1	Replicate 2 Slide 2	Replicate 2 Slide 3
Blue-Green Algae			
Green Algae			
Ankistrodesmus		2	1
Pediastrum	1		
Actinastrum			1
Total	1	2	3
Diatoms			
Asterionella	538	649	580
Cyclotella	3	3	2
Diatoma	2	2	1
Fragilaria	4	6	3
Nitzschia	1	1	
Stephanodiscus	2		
Suriella	2		
Synedra	4	4	1
Total	556	665	587

	Replicate 3 Slide 1	Replicate 3 Slide 2	Replicate 3 Slide 3
Blue-Green Algae			
Green Algae			
Ankistrodesmus	1		1
Pediastrum	1	1	
Actinastrum	1	1	1
Endorina		1	
Micractinium			1
Total	3	3	3
Diatoms			
Asterionella	497	607	544
Cyclotella	1	2	2
Diatoma		1	1
Fragilaria	2	4	2
Nitzschia	3	4	6
Stephanodiscus			1
Synedra	3	8	4
Tabellaria	2		
Total	508	626	560

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4
SPECIAL PLANKTON DISTRIBUTION STUDY
MAY 30, 1974
(SHEET 6 OF 7 SHEETS)

DATE:
SCALE:

TABLE
A-IV-B-1
(Cont'd)

Intake Neal 2

	Replicate 1 Slide 1	 2	 3		Replicate 2 Slide 1	 2	 3		Replicate 3 Slide 1	 2	 3
Blue-Green Algae				Blue-Green Algae				Blue Green Algae			
Green Algae				Green Algae				Green Algae			
Ankistrodesmus	1		1	Ankistrodesmus	2	1	1	Ankistrodesmus	2	1	1
Pediastrum	1		1	Coelastrum	1			Pediastrum	1	1	
Scenedesmus			1	Pediastrum			1	Scenedesmus	3	4	3
Actinastrum	3		2	Scenedesmus	2	2	1	Actinastrum	1	1	
				Ulothrix	1	1		Endorina		1	
				Actinastrum	1	1	1				
Total	5		5	Total	7	5	4	Total	7	8	4
Diatoms				Diatoms				Diatoms			
Asterionella	554	538	597	Asterionella	807	848	834	Asterionella	747	734	749
Cyclotella	1	2		Caloneis		1		Cyclotella	1		1
Diatoma	4			Cyclotella	3	2	1	Diatoma		3	
Fragilaria	6	8	6	Diatoma	1			Fragilaria	2	6	8
Nitzschia	2		2	Fragilaria	1	1	6	Nitzschia	1		3
Stephanodiscus	2			Nitzschia	2	2		Stephanodiscus		1	3
Synedra	2	5	7	Stephanodiscus	2	1		Synedra	6	2	5
Tabellaria		2	2	Synedra	2	1	6	Tabellaria	1		2
Total	571	555	614	Total	818	856	847	Total	758	746	771

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

SPECIAL PLANKTON DISTRIBUTION STUDY

MAY 30, 1974

(SHEET 7 OF 7 SHEETS)

DATE:

SCALE:

TABLE

A-IV-B-1

(Cont'd)

Organism	4/26* 6.7 x 10⁶ gal	4/2* 2.9 x 10⁶ gal	5/9-10 4.2 x 10⁶ gal	5/23* 5.4 x 10⁶ gal	5/31* 5.0 x 10⁶ gal	6/22 3.4 x 10⁶ gal	7/3 3.3 x 10⁶ gal	7/19** 4.6 x 10⁶ gal
Insecta								
Trichoptera (Caddis flies)								
Hydropsychidae	8	5	12	4	4		22	37
Rhyacophilidae	1	2	4			22	30	44
Leptoceridae			12	1		2		
Ephemeroptera (Mayflies)								
Caenis		1	1		5	5	16	1
Stenonema		1	1	5	8	9	5	5
Heptagenia					1			
Isonychia						7	7	5
Tricorythodes						1	6	
Hexagenia						2	2	
Diptera (Midge flies)								
Chironomid pupae		10	1		6		1	1
Chironomid larvae	6		30	6	12	7	19	6
Simuliidae	5	5	2		3			
Anthomyiidae					2			
Tipulidae	1							
Unidentified winged	10	40	25	6	8			
Plecoptera (Stoneflies)								
Paragnetina	1	2	2				1	
Acroneuria					1	2		
Coleoptera (beetles)								
Chrysomelidae					2			
Curculionidae							1	
Hemiptera								
Corixidae			2	1		1		
Notonectidae		1				2		
Mesoveliidae				1				
Crustacea								
Asellus	1	1			2		1	3
Daphnia	200	290	190	150	400	65	750	400
Hyalella							1	
Gastropoda								
Nematoda			1	2		2		3
Hydrazoa	1		6	5	10	10	20	
Hydra				4	50			
Fish								
Eggs				20	22			
Larvae						10	95	25

* Gallons of water filtered

** Neal Unit 2

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

CONDENSER PASSAGE (ENTRAINMENT) DATA FOR NEAL 1 & 2, 1973

(NET OPENING 2' x 3'; MESH SIZE .75 mm)

(SHEET 1 of 2)

DATE:

SCALE:

TABLE

A-IV-B-2

Date:	6/22	7/3	7/11	7/19	7/31
*Net Installed in Intake of Unit:	I	II	II	II	I
Organisms					
Insecta					
Trichoptera					
Hydropsychidae		22	40	37	15
Rhyacophilidae	22	30	25	44	22
Leptoceridae	2		8		
Ephemeroptera					
Caenis	5	16		1	
Isonychia	7	7	4	3	1
Stenonema	9	5	4	5	5
Tricorythodes	1	6	1		2
Hexagenia	2	2	1		
Diptera					
Chironomid pupae		1		1	2
Chironomid larvae	7	19	30	6	4
Tipulidae			1		
Plecoptera					
Paragentina		1	2		
Acroneuria	2				
Coleoptera					
Dystiscidae			3		
Chrysomelidae			7		
Curculionidae		1			
Hemiptera					
Corixudae	1		3		1
Mesoveliidae			1		
Notonectidae	2				
Crustacea					
Asellus		1		3	
Hyalella		1	2		
Daphnia	65	750	75	400	
Gastropoda	2		4	3	2
Nematoda	10	20			
Unidentified Fish Larvae	10	95	45	23	2

*Nitex net (#000 - 1mm)
24 Hour Inflow Net Samples

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

CONDENSER PASSAGE (ENTRAINMENT)
DATA FOR NEAL 1 & 2, 1973
(SHEET 2 OF 2 SHEETS)

DATE: SCALE:

TABLE
A-IV-B-2
(Cont'd)

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I. May 10, 1974

15 minute period	Replicate	
	A	B
Organism		
Insecta		
Trichoptera		
Hydropsychidae		2
Diptera		
Chironomid larvae	1	4
Chironomid pupae	1	2
Crustacea		
Daphnia	>1000	>1000
Fish larvae	1	

30 minute period	Replicate	
	A	B
Organism		
Insecta		
Diptera		
Chironomid larvae		1
Chironomid pupae	1	2
Crustacea		
Daphnia	>1000	>1000
Fish larvae	2	

Source: Hey and Baldwin[31/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

CONDENSER PASSAGE (ENTRAINMENT)
DATA FOR NEAL 1 & 2 1974
(SHEET 1 OF 5 SHEETS)

DATE: SCALE:

TABLE
A-IV-B-3

II May 16 1974

First 30 minute sample	Replicate	
Organism	A	B
Insecta	Sample	
Ephemeroptera		
Hexagenia		1
Diptera		
Chironomid pupae	Accidently	4
Chironomid larvae		13
Crustacea		
Daphnia		> 1000
Fish larvae	Destroyed	1

Second 30 minute sample	Replicate	
Organism	A	B
Insecta		
Trichoptera		
Hydropsychidae	2	
Ephemeroptera		
Stenonema	1	
Hexagenia		1
Diptera		
Chironomid pupae	3	3
Chironomid larvae	10	13
Simulidae	1	2
Crustacea		
Daphnia	> 1000	> 1000
Nematoda	1	
Fish larvae	2	

Source: Hey and Baldwin[31/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

CONDENSER PASSAGE (ENTRAINMENT)
DATA FOR NEAL 1 & 2 1974
(SHEET 2 OF 5 SHEETS)

DATE: SCALE:

TABLE
A-IV-B-3
(Cont'd)

III. May 23, 1974

First 30 minute sample	Replicate	
	A	B
Organism		
Insecta		
Trichoptera		
Hydropsychidae	1	1
Ephemeroptera	1	
Diptera		
Chironomid larvae	3	1
Simuliidae		1
Crustacea		
Daphnia	1000	1000
Fish larvae	1	1
Fish eggs	3	

Second 30 minute sample	Replicate	
	A	B
Organism		
Insecta		
Diptera		
Chironomid pupae	3	1
Chironomid larvae	10	9
Simuliidae		
Crustacea		
Daphnia	1500	1500
Hydrazoa		
Hydra		6
Fish larvae	6	2
Fish eggs	2	

Source: Hey and Baldwin 31/

envirosphere company A DIVISION OF EBASCO SERVICES INCORPORATED	**IOWA PUBLIC SERVICE Co. - NEAL UNIT 4** CONDENSER PASSAGE (ENTRAINMENT) DATA FOR NEAL 1 & 2 1974 (SHEET 3 OF 5 SHEETS)	TABLE A-IV-B-3 (Cont'd)
	DATE: SCALE:	

IV. May 30, 1974

First 30 minute sample:	Replicate	
	A	B
Organism		
Insecta		
Trichoptera		
Hydropsychidae	1	
Diptera		
Chironomid pupae	1	
Chironomid larvae	1	2
Crustacea		
Daphnia	> 1000	> 1000
Fish larvae	3	7

Second 30 minute sample	Replicate	
	A	B
Organism		
Insecta		
Diptera		
Chironomid pupae	1	
Chironomid larvae	2	2
Simuliidae	1	
Coleoptera larvae		1
Crustacea		
Daphnia	>1000	>1000
Fish larvae	11	11

Source: Hey and Baldwin 31/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

CONDENSER PASSAGE (ENTRAINMENT)
DATA FOR NEAL 1 & 2 1974
(SHEET 4 OF 5 SHEETS)

DATE: SCALE:

TABLE
A-IV-B-3
(Cont'd)

Date:	6/7	6/14	6/20	6/27	7/3	7/10	7/18	7/26[2]	8/2
Intake:	I	II	II	II	II	II	II	II	II
Insecta									
Diptera									
Chironomid larvae	7	13	8	7	7	5	5		10
Chironomid pupae	2	3	4	2	3	3	3	1	5
Culicidae									1
Psychodidae					1				
Simuliidae	1								
Ephemeroptera									
Isonychia	2	3	6	3	3	1		2	4
Stenonema	1		1	3					
Trichoptera									
Hydropsychidae				4	9	4	3	7	6
Rhyacophilidae		1		4	1	1	1	3	1
Hydra	300	200	20						5
Microcrustacea	79000	97200	238800	259200	267000	231000	201000	72666	165800
Pelecypoda					1				
Larval Fish	17	72	135	779	92	107	43	7	7
Eggs (Fish	1	2							

[1] Data represents a composite of four 30-minute samples
Counts given as per 200 ml concentrated sample

[2] Only data from one 30-minute sample

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

CONDENSER PASSAGE (ENTRAINMENT)
DATA FOR NEAL 1 & 2 1974
(SHEET 5 OF 5 SHEETS)

DATE: SCALE:

TABLE
A-IV-B-3
(Cont'd)

	Time of Day				Length			Condition	
	8 - 12 am	1 - 5 pm	7 - 11 pm	1 - 5 am	Less than 15 cm	Greater than 15 cm	Not Recorded	Alive	Dead
February 1974									
Burbot	1					1			1
Carpsucker	1	1	4	4	9		1	9	1
Channel catfish	2	2	4	1	7	1	1	6	3
Flathead catfish		1		1	1	1		1	1
Gizzard shad	2			1	1	2			3
Sauger		1				1			1
Smallmouth Buffalo		1				1		1	
Total:	6	6	8	7	18	7	2	17	10
Crayfish (Total)		11	4	5	16		4	16	4
March 1974									
Black bullhead			1		1			1	
Bullhead			1			1		1	
Carpsucker			2		2			2	
Channel Catfish		1	1		2			1	1
Freshwater Drum		1			1				1
Redhorse			1		1			1	
Sauger			2			2			2
Total:	0	2	8		7	3	0	6	4
Crayfish (Total)			3		2		1	2	1
April 1974									
Channel Catfish		1			1			1	
Freshwater Drum		1			1			1	
Perch			1		1			1	
Stonecat			1		1			1	
Total:	0	2	2	0	4	0	0	4	0
May 1974									
Bluegill		1			1			1	
Notropis			1	1	2				2
Total:	0	1	1	1	3	0	0	1	2

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

IMPINGEMENT DATA, NEAL UNITS 1 & 2
1974-1975
(SHEET 1 OF 5)

DATE: SCALE:

TABLE
A-IV-B-4

	Time of Day						Length			Condition	
	9 am - 1 pm	1 - 5 pm	5 - 9 pm	9 pm - 1 am	1 - 5 am	5 - 9 am	Less than 15 cm	Greater than 15 cm	Not Recorded	Alive	Dead
June 1974											
Carp			1				1				1
Notropis				1			1				1
Stonecat		1					1			1	
Total	0	1	1	1	0	0	3	0	0	1	2
July 1974											
Green Sunfish			2				2			2	
Black Crappie	1		2		1	1	5			3	2
Bluegill		2	1				3			2	1
Bluesucker	1	1		1			3				3
Carp					2	1	3			2	1
Carpsucker	1				1		2			1	1
Drum	1	1		6	7	2	17			4	13
Flathead Minnow					1		1			1	
Gizzard Shad	1	1	3	1	4	1	10	1		3	8
Largemouth Bass		2					2			2	
Notropis Spp.	2	1					3			1	2
Sauger					3		3				3
Stone Cat	1						1				1
White Crappie					1	1	2			1	1
Total	8	8	8	8	20	6	57	1		22	36
Crayfish (total)		2				1		1	2	2	1
Frogs	1		1						2	2	
August 1974											
Black Crappie				2		8	10			2	8
Bluegill		4	11	1	5		21			17	4
Carp				1			1			1	
Carpsucker			2	7	11	1	21			10	11
Drum	1	1	4	18	15	8	47			24	23
Flathead Catfish		2					2				2
Gizzard Shad	28	3	7	20	55	77	195			45	150
Green Sunfish		1				1	2			2	
Notropis						1	1				1
Perch	2	1					3				3
Sauger			1				1			1	
Stone Cat	1						1				1
White Bass			1				1				1
White Crappie	3	1	7	4		2	17			10	7
Total	35	18	33	53	86	96	323	0	0	112	211
Crayfish (total)					3	1	1		3	2	2

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

IMPINGEMENT DATA, NEAL UNITS 1 & 2
1974-1975
(SHEET 2 OF 5)

DATE: SCALE:

TABLE
A-IV-B-4
(Cont'd)

	Time of Day						Length			Condition	
	9 am - 1 pm	1 - 5 pm	5 - 9 pm	9 pm - 1 am	1 - 5 am	5 - 9 am	Less than 15 cm	Greater than 15 cm	Not Recorded	Alive	Dead
September 1974											
Bluegill	1		6				7			7	
Carpsucker				1			1				1
Drum			6	5	6	5	22			12	10
Gizzard Shad	4	4		3	13		24			8	16
Goldeye			1			2	3				3
Green Sunfish	1						1				1
Largemouth Bass		1					1			1	
White Crappie		2	1				3			2	1
Total	6	7	14	9	19	7	62			30	32
October 1974											
Bass				1			1			1	
Bluegill	3	2	3	1	1		10			10	
Bullhead Minnow				1			1				1
Carp						1	1			1	
Carpsucker				1			1			1	
Channel Catfish					1	1	2			2	
Drum	1	1	10	15	7	3	37			28	9
Flathead Catfish		1	1	3	3		8			7	1
Gizzard Shad	3	3	2	3	6	2	19			14	5
Goldeye				2			2			2	
Green Sunfish		3					3			3	
Notropis	1			1			2			1	1
Perch	1		1				2			2	
Stone Cat					1		1			1	
White Crappie	4	1					5			4	1
Total	13	11	17	28	19	7	95			77	18
Crayfish (total)		1	1			1	3			3	

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A DIVISION OF EBASCO SERVICES INCORPORATED

IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

IMPINGEMENT DATA, NEAL UNITS 1 & 2
1974-1975
(SHEET 3 OF 5)

DATE: SCALE:

TABLE
A-IV-B-4
(Cont'd)

	Time of Day						Length			Condition	
	9 am - 1 pm	1 - 5 pm	5 - 9 pm	9 pm - 1 am	1 - 5 am	5 - 9 am	Less than 15 cm	Greater than 15 cm	Not Recorded	Alive	Dead
November 1974											
Bluegill	2	6		1		1	10			10	
Bullhead			1	2			3			3	
Channel Catfish		1	1	1	2		5			5	
Drum	6	3	9	12	11	8	49			42	7
Flathead Catfish				2		2	4			4	
Gizzard Shad	5	1	10	2	2	1	18		3	18	3
Goldeye				1			1			1	
Mooneye				1			1			1	
Perch			1				1			1	
Redhorse		1					1			1	
Shiner Minnow		1					1			1	
Shovelnose Sturgeon					1				1	1	
Stonecat	1						1			1	
White Bass		1	1	1			2		1	3	
Total	14	14	23	23	16	12	97		5	92	10
Crayfish (total)	1		1	3	1					6	
December 1974											
Carpsucker	2	1		1			4			3	1
Channel Cat	2	2	4	3	4	2	13	4		15	2
Drum	2	1	1	1	2		4	3		5	2
Flathead Cat		1				1	2			1	1
Gizzard Shad	6	9	2	3	2	4	20	6		15	11
Northern Pike				1			1			1	
Notropis				1			1			1	
Perch						1	1			1	
Sauger		1	1				1	1		2	
Smallmouth Bass				1			1				1
White Bass				1			1			1	
Total	12	16	8	12	8	8	49	14		45	18
Crayfish (total)	1	1	5	8	5	4	24	0		21	3

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

IMPINGEMENT DATA, NEAL UNITS 1 & 2
1974-1975
(SHEET 4 OF 5)

DATE:
SCALE:

TABLE
A-IV-B-4
(Cont'd)

	Time of Day						Length			Condition	
	9 am - 1 pm	1 - 5 pm	5 - 9 pm	9 pm - 1 am	1 - 5 am	5 - 9 am	Less than 15 cm	Greater than 15 cm	Not Recorded	Alive	Dead
January 1975											
Channel Cat	2	1		1		2	3	3		5	1
Drum	2	2	2	2	3	1	12			7	5
Flathead Cat		1	1				1	1		2	
Gizzard Shad	4	1	1	2		3	8	3		6	5
Goldeye						1	1			1	
Total	8	5	4	5	3	7	25	7		21	11
Crayfish (total)	2	4	3	12	3	5	28	1		28	1
February 1975											
Carpsucker				1	2	2	5	0		4	1
Channel Cat	1	1		3	1	2	2	8		10	0
Drum	2	1	2	1	4		7	3		10	0
Flathead Cat		1					1			1	
Notropis					1		1			1	
Sauger				1			1				1
Shortnose Gar	1							1		1	
Stonecat		1					1			1	
Total	4	4	4	6	8	4	18	12		28	2
Crayfish (total)	5	4	4	0	0	1	14	0		12	2

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

IMPINGEMENT DATA, NEAL UNITS 1 & 2
1974-1975
(SHEET 5 OF 5)

DATE: SCALE:

TABLE
A-IV-B-4
(Cont'd)

June 3, 1974

Sampling Sites:*	Downstream			Upstream		
	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8
Blue-Green Algae						
Oscillatoria	176,823	159,507	115,218	48,293	77,589	31,302
Total Blue-Green	176,823	159,507	115,218	48,293	77,589	31,302
Green Algae						
Ankistrodesmus	333	2,997	4,662	999	333	1,998
Closterium			666		333	333
Pediastrum		1,665	999	333		
Scenedesmus	2,331			1,998	2,331	2,664
Ulothrix	1,998			333	333	999
Actinastrum	666		666	333		1,665
Total Green	5,328	4,662	6,993	3,996	3,330	7,659
Diatoms						
Asterionella	13,320	8,325	3,996	3,996	3,996	
Cyclotella						333
Diatoma	18,315	19,647	14,985	42,624	11,655	11,322
Fragilaria	3,330	6,327	6,327	2,997	2,664	4,662
Melosira	333		666			
Navicula	44,289	333	666	109,890	1,998	11,322
Nitzschia	144,855	331,335	178,821	231,768	144,189	238,761
Synedra	1,332	2,997	4,329	2,997	1,332	1,332
Tabellaria						
Total Diatoms	225,774	368,964	210,123	394,272	165,834	267,732

*Description of Periphyton Study Sampling Sites

No. 1 - Iowa shore, 400 ft south of plant No. 6 - Iowa shore, 200 ft north of plant
No. 2 - Iowa shore, 300 ft south of plant No. 7 - Iowa shore, 300 ft north of plant
No. 3 - Iowa shore, [illegible] ft south of plant No. 8 - Iowa shore, [illegible] ft north of plant

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

1974 PERIPHYTON STUDY USING NATURAL ROCK SUBSTRATES (Counts/cm²)
(SHEET 1 OF 4)

DATE:
SCALE:

TABLE
A-IV-B-5

June 3, 1974

Sampling Sites:*	Downstream			Upstream		
	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8
Water Temperature (°C)	23.0	23.0	23.0	23.0	23.0	23.0
Blue-Green Algae						
Oscillatoria	83,000	33,000	43,500		16,000	64,500
Total Blue-Green	83,000	33,000	43,500		16,000	64,500
Green Algae						
Chlorella		6,000	158,000			13,000
Pediastrum	500			1,000		
Scenedesmus	500			500		
Actinastrum				500		
Phytoconis			1,500			
Total Green	1,000	6,000	159,500	2,000		13,000
Diatoms						
Asterionella				8,500	500	
Diatoma	2,500			1,000	500	1,000
Fragilaria	4,500	500		500	1,000	1,000
Melosira	500		500		1,000	
Navicula	277,500	5,000	2,500	9,000	89,000	27,000
Nitzschia	28,000	3,500	13,000	36,500	1,500	35,000
Synedra	500					
Total Diatoms	313,500	9,000	16,000	55,500	93,500	64,000

*Description of Periphyton Study Sampling Sites

No. 1 - Iowa shore, 400 ft south of plant
No. 2 - Iowa shore, 300 ft south of plant
No. 3 - Iowa shore, 200 ft south of plant
No. 6 - Iowa shore, 200 ft north of plant
No. 7 - Iowa shore, 300 ft north of plant
No. 8 - Iowa shore, 400 ft north of plant

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

1974 PERIPHYTON STUDY USING NATURAL ROCK SUBSTRATES (Counts/cm^2)
(SHEET 2 OF 4)

DATE:

SCALE:

TABLE
A-IV-8-3
(Cont'd)

July 29, 1974

Sampling Sites:*	Downstream			Upstream		
	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8
Water Temperature (°C)	27	27	27	26	26	26
Blue-Green Algae						
Oscilatoria				1,000		
Green Algae						
Cladophora				500		500
Microspora				500		
Pediastrum						500
Scenedesmus	500	1,500	500	1,000		
Stigeocloium		1,000	3,500			
Ulothrix			500	1,000		
Total Green	500	2,500	4,500	3,000	0	1,000
Diatoms						
Asterionella						
Cymbella	3,500	1,000	500	2,500	500	
Diatoma		500				
Melosira		1,000	500	2,500		1,000
Navicula	3,761,745	3,992,071	2,040,945	5,734,669	2,431,938	6,055,027
Nitzschia	611,316	1,153,137	858,311	432,487	306,824	68,498
Synedra	500	500		1,000		
Total Diatoms	4,377,061	5,148,208	2,900,256	6,172,146	2,740,262	6,124,525

*Description of Periphyton Study Sampling Sites

No. 1 - Iowa shore, 400 ft south of plant
No. 2 - Iowa shore, 300 ft south of plant
No. 3 - Iowa shore, 200 ft south of plant
No. 6 - Iowa shore, 200 ft north of plant
No. 7 - Iowa shore, 300 ft north of plant
No. 8 - Iowa shore, 400 ft north of plant

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

1974 PERIPHYTON STUDY USING NATURAL ROCK SUBSTRATES (Counts/cm²)
(SHEET 3 OF 4)

DATE:

SCALE:

TABLE
A-IV-B-5
(Cont'd)

August 28, 1974

Sampling Sites:*	Downstream			Upstream		
	No. 1	No. 2	No. 3	No. 6	No. 7	No. 8
Temperature (°C)	24.5	24.5	24.5	24	24	24
Blue-Green Algae						
Oscillatoria	1.500		2.500	26.500	24.000	14.500
Green Algae						
Cladophora	3.000	500	2.000	1.500		1.500
Pediastrum			500	500		
Rhizoclonium		500		2.000	1.500	3.000
Scenedesmus					1.500	2.000
Stigeocloium	1.500	1.500	5.500	3.000	1.000	2.500
Ulothrix			1.000	4.500	3.000	1,500
Total Green	4.500	2.500	9.000	11.500	7.000	10.500
Diatoms						
Cymbella	8.000	2.500	15.500	2.500	1.000	5.500
Diatoma	7.500	11.000	8.000			2.500
Fragilaria	1.000		1.000	500		1.000
Melosira				1.500		2,500
Navicula	2.216.578	3.274.869	945.000	631,000	299,000	104,000
Nitzschia	558.311	333.320	109.500	98.000	92.000	89,000
Synedra			500		500	
Total Diatoms	2.791.389	3.621.689	1.079.500	733.500	392.500	204.500

*Description of Periphyton Study Sampling Sites

No. 1 - Iowa shore, 400 ft south of plant
No. 2 - Iowa shore, 300 ft south of plant
No. 3 - Iowa shore, 200 ft south of plant
No. 6 - Iowa shore, 200 ft north of plant
No. 7 - Iowa shore, 300 ft north of plant
No. 8 - Iowa shore, 400 ft north of plant

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

1974 PERIPHYTON STUDY USING NATURAL ROCK SUBSTRATES (Counts cm^2)
(SHEET 4 OF 4)

DATE: SCALE:

TABLE
A-IV-B-5
(Cont'd)

Species (Common & Scientific Name) **Channel Catfish (Ictalurus punctatus)**

Lethal Thresholds **(Threshold/Acclimination)**

Upper		**Life Stage**	**Reference (IV-B)**
34	maximum tolerated before displacement		Bush et al[50]
36	suggested max. for survival of juvenile & adult		MPCA[61]
31/15	temp. of maximum survival	larvae	EPA[45]
30.4/15		adult	EPA[45]
35.5/25		juvenile	EPA[45]
37/30		juvenile	EPA[45]
38/35		juvenile	EPA[45]
33.5/25		adult	EPA[45]
36.6/26		juvenile	EPA[51]
32.8/20		adult	EPA[51]
Lower			
0/15		adult	EPA[45]
0/20		adult	EPA[45]
0/25		adult	EPA[45]
Temperature Preference			
26.5 - 32.3			Gammon[57]
30 32 opt.			Gammon[56]

Spawning Temperature	**Optimum**	**Range**	**Reference**
	26.7		Christianson & Tichenor[46]
	27 maximum weekly avg.		MPCA[61]
	26.7	21.1 - 29.4	EPA[45]
		18 20	EPA[51]
Hatching Success Temperature			
	26.7		Christianson & Tichenor[46]
	29- maximum for survival		MPCA[61]
	21.7	18.3 29.4	EPA[45]
Growth Temperature			
	30-juvenile	29 30 larvae	EPA[45]
	30		EPA[51]
	32-juvenile & adult		MPCA[61]
	33.9		Christianson & Tichenor[46]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 1 OF 13)

DATE:

TABLE
A-IV-B-6

Species (Common & Scientific Name) **Northern Pike (Esox lucius)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper	Life Stage	Reference
32.2/25	juvenile	EPA[45]
32.7/27	juvenile	EPA[45]
33.2/30 – ultimate incipient lethal	juvenile	EPA[45]
30 suggested max. for survival of juvenile & adult		MPCA[61]
34 max. tolerated before displacement		Bush et al[50]
25/17.7	at hatch	EPA[45]
28.4/17.7	larvae	EPA[45]

Lower	Life Stage	Reference
3.2/17.7	larvae	EPA[45]

Temperature Preference

	Optimum	Range	Reference
Spawning Temperature		4.4 18.5	EPA[45]
	8.9		Christianson & Tichenor[46]
	12 maximum weekly avg.		MPCA[61]
Hatching Success Temperature	19 max. for survival		MPCA[61]
	6.9 19.2 for normal hatch		EPA[45]
Growth Temperature	28 juvenile & adult		MPCA[61]
	28.9		Christianson & Tichenor[46]
	20.8 – larvae		EPA[45]
	26 juvenile		EPA[45]
		18 25.6 larvae	EPA[45]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 2 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **Carp (Cyprinus carpio)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper	**Life Stage**	**Reference**
31 34/20	juvenile	Carlander[58]
35.7/26	juvenile	
34/20	juvenile	EPA[45]
36 – maximum tolerated before displacement		Bush et al[50]

Lower	**Life Stage**	**Reference**
0.7 -		Carlander[58]
1.7 inactive		Carlander[58]

Temperature Preference	**Life Stage**	**Reference**
(31 – 32) (35 – 35)	juvenile	EPA[45]
17/10	juvenile	EPA[45]
32	adult	Christianson & Tichenor
27.5 34.5		Gammon[57]
33 35 opt		Gammon[56]

Spawning Temperature	**Optimum**	**Range**	**Reference**
		18 20	EPA[51]
	20	16.7 - 22	EPA[45]
		16 26	EPA[45]
	21 - maximum weekly avg.		MPCA[61]
Hatching Success Temperature			
	26 maximum for survival		MPCA[61]
Growth Temperature			
	33.9		Christianson & Tichenor[46]

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IOWA PUBLIC SERVICE Co. – NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 3 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **Gizzard Shad (Dorosoma cepedianum)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper	Life Stage	Reference
36 maximum tolerated before displacement		Bush et al50/
34/25	juvenile	EPA45/
36/30	juvenile	EPA45/
36.5/35	juvenile	EPA45/

Lower	Reference
11/25	Christianson & Tichenor46/
20/35	Christianson & Tichenor46/

Temperature Preference

		Reference
23.5	30	Gammon57/
28.5	31 opt	Gammon56/

Spawning Temperature	Optimum	Range	Reference
		16 18	EPA45/
	26.7		Christianson & Tichenor46/
Hatching Success Temperature			
	26.7		Christianson & Tichenor46/
Growth Temperature			
	33.9		Christianson & Tichenor46/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 4 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **White Sucker (Catostomus commersoni)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper	**Life Stage**	**Reference**
26/5	juvenile	EPA 45/
28/10	juvenile	EPA 45/
28.1/10	larvae	EPA 45/
29.3/15	juvenile	EPA 45/
30.7/15	larvae	EPA 45/
21/15	egg	EPA 45/
29.3/20	juvenile	EPA 45/
30.5/21	larvae	EPA 45/
29.3/25	juvenile	EPA 45/
31.2/25 26	juvenile	EPA 45/

Lower		
8.5/15	egg	EPA 45/
2.5 3/20	juvenile	EPA 45/
6/25	juvenile	EPA 45/
6.1/21	larvae	EPA 45/

Temperature Preference		
19 21		EPA 45/

	Optimum		**Range**		**Reference**
Spawning Temperature	10		4.5 18		EPA 45/
	10	maximum weekly avg.			MPCA 61/
Hatching Success Temperature	15		8 21		EPA 45/
	21	max. for survival			MPCA 61/
Growth Temperature	27	larvae	24 27	larvae	EPA 45/
	28	juvenile & adult			MPCA 61/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 5 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **White Crappie (Pomoxis annularis)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper

Upper		Life Stage	Reference
34	maximum tolerated before displacement		Bush et al[50]
32.6	upper incipient lethal	juvenile	EPA [45]

Lower

Temperature Preference

		Reference
22	27	EPA [45]
21	27	Gammon [57]
27	31 opt	Gammon [56]

Spawning Temperature	Optimum		Range		Reference
	18	maximum weekly avg.			MPCA [61]
			17.8	20	EPA [45]
			16	20	EPA [45]
			14	16	EPA [45]
Hatching Success Temperature					
	23	max. for survival			MPCA [61]
			21.1	23.3	EPA [45]
Growth Temperature					
	27	juvenile & adult			MPCA [61]
	25	juvenile			EPA [45]
	32.2				Christianson & Tichenor [46]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 6 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **White Bass (Morone chrysops)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper	**Life Stage**	**Reference**
30 – maximum tolerated before displacement		Bush et al 50/

Lower		
14.4/17.2 – percent mortality not given	larvae	EPA 45/

Temperature Preference		
23 28.5		Gammon 57/
28 29.5 opt		Gammon 56/

Spawning Temperature	**Optimum**	**Range**	**Reference**
		10 12	EPA 51/
		14.4 23.9	EPA 45/
	19 maximum weekly avg.		MPCA 61/
Hatching Success Temperature			
	24 maximum for survival		MPCA 61/
		15.6 16.7	EPA 45/
Growth Temperature			
	33.9		Christianson & Tichenor 46/
		22.6 23.6 juvenile	EPA 45/

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IOWA PUBLIC SERVICE Co. – NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 7 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) Sauger (Stizostedion canadense)

Lethal Thresholds **(Threshold/Acclimation)**

Upper	**Life Stage**	**Reference**
30 max. tolerated before displacement		Bush et al 50/

Lower

Temperature Preference

27	29 opt	Gammon 57/
22	28	Gammon 56/
18.6	19.2	EPA 45/

Spawning Temperature	**Optimum**	**Range**	**Reference**
		5 7	EPA 51/
	10 opt		EPA 45/
		5.6 14.4	EPA 45/
	10 maximum weekly avg.		MPCA 61/
	8.9		Christianson & Tichenor 46/
Hatching Success Temperature			
	8.9		Christianson & Tichenor 46/
	12 15	10 16	EPA 45/
	21 maximum for survival		MPCA 61/
Growth Temperature			
	25		MPCA 61/
	28.9		Christianson & Tichenor 46/

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envirosphere company	IOWA PUBLIC SERVICE Co. - NEAL UNIT 4	TABLE A-IV-8-6 (Cont'd)
	FISH TEMPERATURE DATA (°C) (SHEET 8 OF 13)	
	DATE:	

Species (Common & Scientific Name) Buffalo (Ictiobus spp.)

Lethal Thresholds (Threshold/Acclimation)

Upper		Life Stage	Reference
30	maximum tolerated before displacement		Bush et al[50/]

Lower

Temperature Preference

		Reference
31	34 optimum	Gammon[57/]
27	34.5	Gammon[56/]

Spawning Temperature	Optimum		Range		Reference
			14	16	EPA[51/]
	17				Carlander[58/]
	26.7				Christianson & Tichenor[46/]
Bigmouth	16.7		14.4	26.7	EPA[45/]
Smallmouth	16.7		13.9	23.9	EPA[45/]
Bigmouth	17	maximum weekly avg.			MPCA[61/]
Smallmouth	17	maximum weekly avg.			MPCA[61/]

Hatching Success Temperature					Reference
Bigmouth			13.9	16.7	EPA[45/]
Smallmouth			13.9	21.1	EPA[45/]
Bigmouth	27	for survival			MPCA[61/]
Smallmouth	21	for survival			MPCA[61/]
	26.7				Christianson & Tichenor[46/]

Growth Temperature

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 9 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **Bullhead (Ictalurus spp)**

Lethal Thresholds **(Threshold Acclimation)**

Upper			**Life Stage**	**Reference**
Black	34	maximum tolerated before displacement		Bush et al 50/
Brown	27.8/5			Coutant 29/
Brown	29/10			Coutant 29/
Brown	31/15			Coutant 29/
Brown	32.5/20			Coutant 29/
Brown	33.8/25			Coutant 29/
Brown	34.8/30			Coutant 29/
Brown	34.8/34			Coutant 29/

Lower		**Reference**
	0.5/20	Coutant 29/
	4/25	Coutant 29/
	6.8/30	Coutant 29/

Temperature Preference

Spawning Temperature	**Optimum**	**Range**	**Reference**
Hatching Success Temperature			
Growth Temperature			

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 10 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) Carpsucker (Carpiodes carpio)

Lethal Thresholds (Threshold Acclimation)

Upper		Life Stage	Reference
32	maximum tolerated before displacement		Bush et al[50]

Lower

Temperature Preference

	Reference
31.5 - 34.5 opt	Gammon[56]

Spawning Temperature	Optimum	Range	Reference
		23 25	EPA[51]
		18.3 24	Jester[62]

Hatching Success Temperature

Growth Temperature

	Optimum	Reference
	33.9	Christianson & Tichenor[46]

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FISH TEMPERATURE DATA (°C)
(SHEET 11 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont.'d)

Species (Common & Scientific Name) Freshwater Drum (*Aplodinotus grunniens*)

Lethal Thresholds (Threshold Acclimation)

Upper	Life Stage	Reference

Lower

Temperature Preference

		Reference
23.5	30	Gammon 56/
29	31 opt	Gammon 56/

Spawning Temperature	Optimum	Range	Reference
	21.1	18.9 24.4	EPA 45/
	21 maximum weekly avg.		MPCA 61/

Hatching Success Temperature			
		22.2 25.6	EPA 45/
	26 maximum for survival		MPCA 61/

Growth Temperature			
	32.2		Christianson & Tichenor 46/

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 12 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Species (Common & Scientific Name) **Shortnose Gar (Lepisosteus platostomus)**

Lethal Thresholds **(Threshold/Acclimation)**

Upper	**Life Stage**	**Reference**

Lower		

Temperature Preference

33 35 opt	Gammon[56/]

Spawning Temperature	**Optimum**	**Range**	**Reference**
		19 23.5	Carlander [58/]

Hatching Success Temperature

Growth Temperature

33.9	Christianson & Tichenor[46/]

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

FISH TEMPERATURE DATA (°C)
(SHEET 13 OF 13)

DATE:

TABLE
A-IV-B-6
(Cont'd)

Section A-IV-C

This section contains a discussion of the analytical model used in the Neal Unit 4 stack height selection study. This supplements information provided in Section IV-C of the Environmental Impact Statement.

APPENDIX A-IV-C

STACK SELECT DIFFUSION MODEL

1. Basic Model Operation

The diffusion model STACK SELECT* performs the following functions sequentially for each hour of meteorological data in the period of record being examined:

a. Surface or low level wind speeds are adjusted to stack top wind speed using the relationship

$$u = u_1 \left(\frac{h_z}{h_1} \right)^{\frac{1}{10-S}}$$

where:

u = wind speed at stack top, mps

u_1 = surface or low level wind speed, mps

h_z = height of the top of the stack above ground level, m

h_1 = height of low level or surface wind speed sensor above ground level, m

S = stability class number

b. Atmospheric stability classes are developed from each hour of surfact meteorological data using the CONVERT* program. This program follows the technique outlines by Turner(1) for developing such stability information. A summary of these stability classes and their relationship to surface meteorological data is presented in Exhibit A-IV-C-1.

c. If calm conditions occur, a wind speed of 1.5 knots is substituted for the surface wind speed value.

d. Wind direction data reported by National Weather Surface stations are reported by sector; sector widths are either 10 or 22½ degrees depending upon the type of station involved and the year of observation. Following the suggestion of D B Turner(2), the model randomly assigns exact wind directions

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TURNER-PASQUILL STABILITY CLASS RELATIONSHIPS AND STRATIFICATION OF STABILITY ACCORDING TO WEATHER CONDITIONS

Turner-Pasquill Stability Class Relationships and Stability Description

Turner Stability Class	Pasquill Stability Class	Stability Description
1	A	Extremely Unstable Conditions
2	B	Unstable Condition
3	C	Slightly Unstable Conditions
4	D	Neutral Condition
5	E	Slightly Stable Condition
6	F	Stable Conditions
7	G	Extremely Stable Conditions

STRATIFICATION OF TURNER-PASQUILL STABILITY ACCORDING TO WEATHER CONDITIONS

	Daytime Conditions Incoming Radiation				Day or Night	Nighttime Conditions Outgoing Radiation	
Surface Wind Speed (Kts)	Strong	Moderate	Slight	Weak	Balanced Radiation	Weak	Strong
0-1	A	A	B	C	D	F	G
2-3	A	B	B	C	D	F	G
4-5	A	B	C	D	D	E	F
6	B	B	C	D	D	E	F
7	B	B	C	D	D	D	E
8-9	B	C	C	D	D	D	E
10	C	C	D	D	D	D	E
11	C	C	D	D	D	D	D
≥ 12	C	D	D	D	D	D	D

Opaque Sky Cover Used To Determine Stability Class

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

TURNER-PASQUILL STABILITY CLASS RELATIONSHIPS AND STRATIFICATION OF STABILITY ACCORDING TO WEATHER CONDITIONS

DATE: SCALE:

EXHIBIT A-IV-C-1

within the sectors specified by the National Weather Service data. This procedure avoids imposing centerline concentrations on grid receptor points and also includes in the calculations the random wind fluctuations which are present in the actual offsite data.

e. For calm conditions, the wind direction is assumed to fall in the same sector as the wind of the hour preceding the calm for a time period equal to one-half of each calm period (fractions are rounded upward). Exact wind directions are assigned as in Step d. The remaining half of all calm periods have a random assignment of both the wind sectors and specific directions within the sectors.

f. The heat emission rate for each hour is calculated using the following equation:

$$H = 252\ M\ C_P\ (T_s - T_A)$$

where:

H = heat emission rate, cal/sec

M = flue gas mass release rate, lb/sec

C_P = flue gas mean specific heat, $\frac{\text{Btu}}{\text{lb-}^{o}\text{R}}$

T_s = stack exit temperature, °R

T_A = ambient temperature, °R

g. Using the heat emission rate calculated in Step and an approximation suggested by Briggs (3), the Briggs buoyancy flux parameter is calculated as

$$F = 3.7 \times 10^{-5} H$$

where:

F = buoyancy flux parameter, m^4/sec^3

h. The buoyancy flux parameter is used to define the downwind distance at which atmospheric turbulence begins to dominate entrainment as follows:

$$x^* = 14\ F^{5/8} \text{ if } F \leq 55$$
$$x^* = 34\ F^{2/5} \text{ if } F > 55$$

where

x^* = downwind distance of point at which turbulence begins to dominate entrainment, m

i. For unstable and neutral conditions, x^* is then used to calculate the downwind distance to the final rise point of the plume using the following equation

$$x_f = 3.5\ x^*$$

where:

x_f = downwind distance of point of final rise, m

j. Under neutral or unstable atmospheric conditions, when a given grid point is closer to the stack than the distance x_f, the plume is predicted to rise according to the following relationship as reported by Briggs(4):

$$\Delta h = \frac{1.6\ F^{1/3}\ x^{2/3}}{u}$$

where: Δh = plume rise, m
F = buoyancy flux parameter, m^4/sec^3
x = downwind distance from source, m
u = wind speed at stack top, mps

k. Under neutral or unstable conditions, when a given grid point is farther from the stack than the distance of x_f, the plume is considered to reach a final height as given by the following Briggs(4) formula:

$$\Delta h_f = \frac{1.6\ F^{1/3}}{u}\ x_f^{\ 2/3}$$

l. Under stable atmospheric conditions, the horizontal distance to the point of final rise is defined by the following relationship:

$$X_{fs} = \frac{3.14u}{s^{1/2}}$$

where: X_{fs} = downwind distance to a point of final rise, m
u = wind speed at stack top, mps
s = stability parameter = $\frac{g\Delta\theta}{T\Delta z}$, sec^{-2}
g = acceleration of gravity, mps^2
T = ambient air temperature, ° K
$\frac{\Delta\theta}{\Delta z}$ = potential temperature lapse rate of environment, ° K/m

m. Under stable atmospheric conditions, for points closer than x_{fs}, the plume rise equation used is identical with that specified in Step j. For points further from the origin than x_{fs}, the following Briggs(4) stable formula is used:

$$\Delta h = 2.4 \left(\frac{F}{us} \right)^{1/3}$$

where: Δh = plume rise, m

u = wind speed at stack top, mps

F = buoyancy flux parameter, m^4/sec^3

s = defined in 10a above

n. To account for the downwash under high wind conditions, a procedure reported by Gifford (5) is utilized. Whenever the plume velocity is less than 1.5 times the stack top wind speed, the correction term described below is subtracted from the plume rise calculated in Steps j. through m. This downwash correction term is calculated as follows:

$$\Delta h_d = 3 \, (1.5 - w_o/u) \, D$$

where:

Δh_d = downwash correction, m

w_o = plume exit velocity, mps

u = stack top wind speed, mps

D = outer diameter of stack, m

o. A final adjustment is made to the plume rise model to account for the effects of terrain. This final adjustment is incorporated into the following equation: $h = h_s + \Delta h - \Delta h_d - K(h_t - h_b)$

h = effective height of plume, m

h_s = stack height, m

Δh = plume rise (Step 9, 10 or 11)

h_d = downwash correction

h_t = height of terrain point above mean sea level, m

h_b = height of base of track above mean sea level, m

K = terrain correction factor: 1.0 for stable cases; 0.5 for unstable and neutral conditions.

p. Once the effective height of the pollutant plume has been determined, the computer program calculates hourly ground level pollutant concentrations for each stack/grid point combination by the basic Gaussian diffusion equation as reported by Turner (6):

$$X = \frac{Q}{\pi \sigma_y \sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \exp\left[-\frac{1}{2}\left(\frac{h}{\sigma_z}\right)^2\right]$$

where:

X = ground level concentration of pollutant, ug/m^3

Q = pollutant release rate, ug/sec

σ_y = horizontal dispersion coefficient, m (See Exhibit C-2)

σ_z = vertical dispersion coefficient, m (See Exhibit C-3)

u = stack top wind speed, mps

h = effective plume height, m

y = cross wind distance between plume centerline and grid point, m

q. The horizontal and vertical dispersion coefficients are those reported by Turner(6). They are calculated in the model using the subroutine POLYN developed by J. F. Sagendorf(7).

r. Ground level sulfuric acid (H_2SO_4) mist concentrations, due to the in-plume oxidation and hydration of SO_2, are calculated based on an assumed first-order humidity-dependent reaction rate. The H_2SO_4 concentration is obtained using the equation

$$X_{H_2SO_4} = \frac{98 \text{ (Molec Wgt } H_2SO_4)}{64 \text{ (Molec Wgt } SO_2)} \cdot X_{SO_2} \left[1 - \exp(-kt)\right]$$

where:

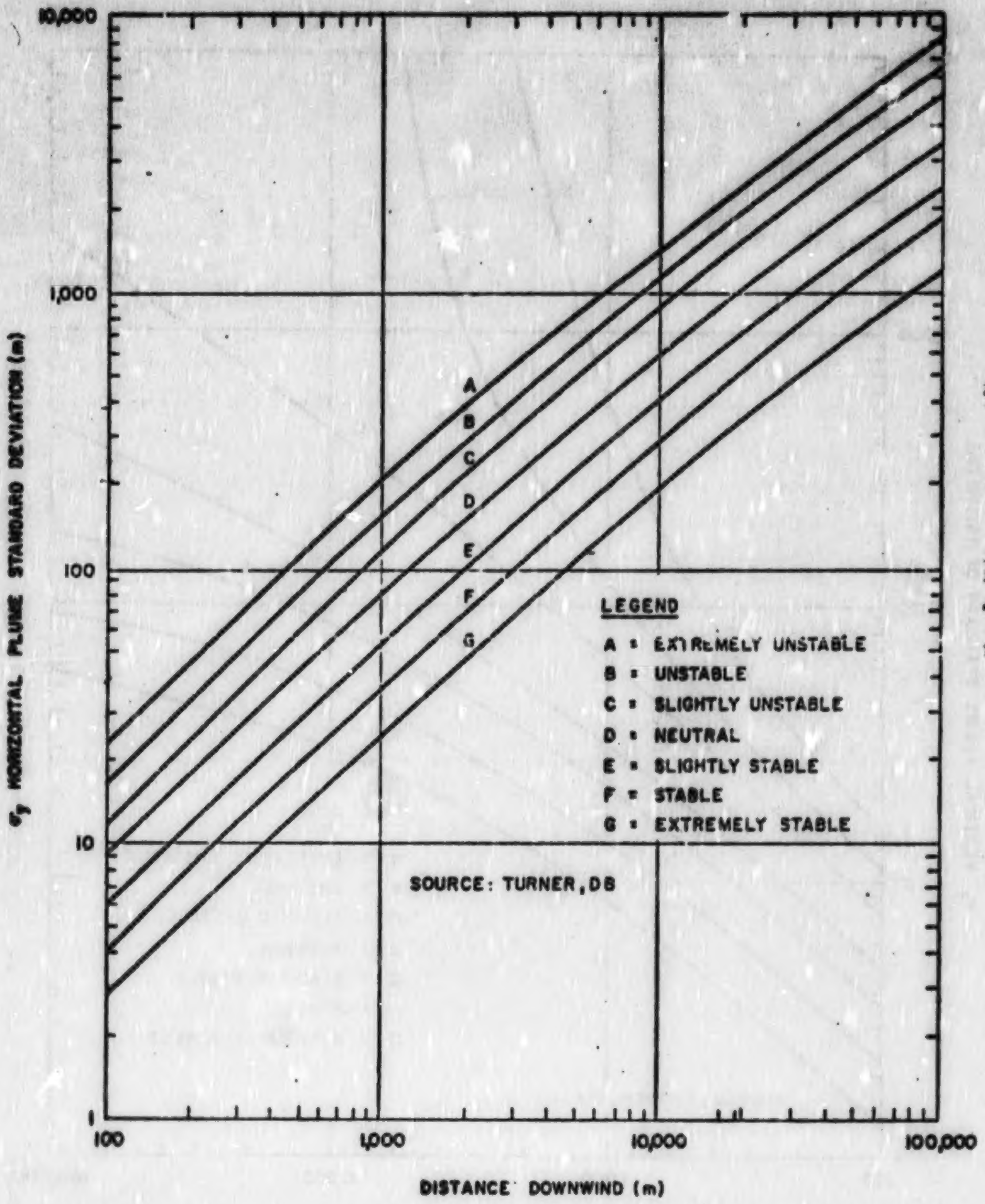
$X_{H_2SO_4}$ = ground level H_2SO_4 concentration

X_{SO_2} = ground level SO_2 concentration calculated assuming no oxidation

k = first-order humidity-dependent reaction rate constant (see below)

t = travel time from stack top to receptor point = X/U_s

The value of k has been conservatively approximated utilizing available in-plume measurements taken by F, E, Gartrell et al (see Atmospheric Oxidation of SO_2 in Coal-burning Power Plant Plumes", American Industrial Hygiene Association Journal, 1963, pp. 113-120) of the Tennessee



SOURCE: TURNER, DB

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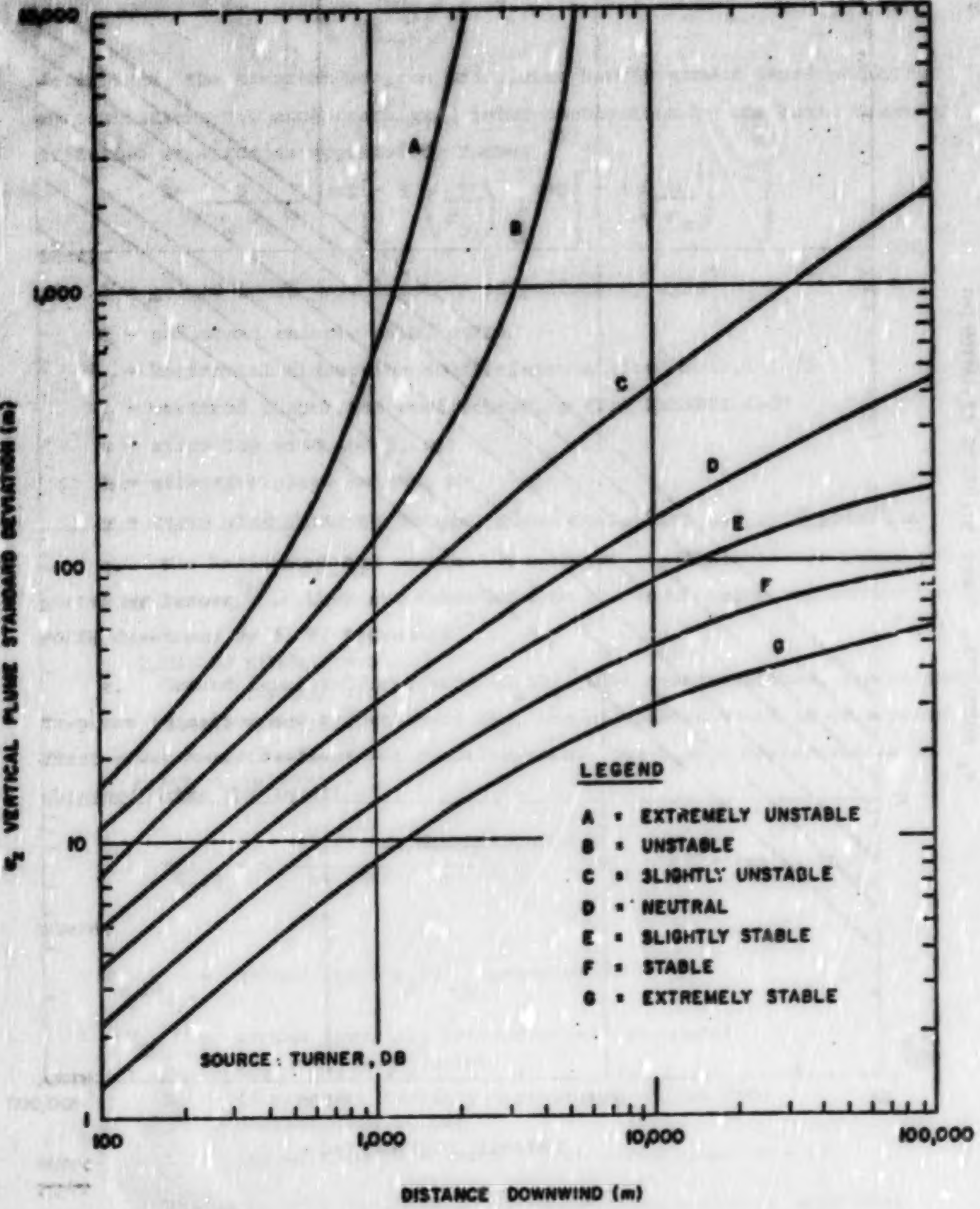
HORIZONTAL STANDARD DEVIATIONS OF A PLUME

DATE: SCALE:

EXHIBIT A-IV-C-2



SOURCE: TURNER, DB

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VERTICAL STANDARD DEVIATIONS
OF A PLUME

DATE:
SCALE:

EXHIBIT A-IV-C-

Valley Authority and by L. Newman et al (see "The Application of an Isotopic Ratio Technique to a Study of the Atmospheric Oxidation of Sulfur Dioxide in the Plume from a Coal-Fired Power Plant, BNL 19462, 1975) of the Brookhaven National Laboratory. Curve-fitting yielded the dimensional relationship

$$k = 10 \exp \sqrt[5]{\frac{RH - 70}{4}}$$

where:

k = first-order reaction rate constant (%/hr)

RH = relative humidity of the atmosphere (%)

The data upon which the above equation is based, which were taken at downwind distances ranging from 8.8 to 48.3 kilometers, are presented in Table A-IV-C-1. The relationship of the reaction rate constant to the relative humidity is presented graphically in Exhibit A-IV-C-4.

The rapid increase of the reaction rate constant observed as the atmospheric relative humidity approaches and exceeds 70 percent is believed to be indicative of an aqueous particulate-catalyzed conversion mechanism. In support of such a hypothesis is the following statement from the U.S. EPA's Air Quality Criteria for Particulate Matter: "When the relative humidity exceeds approximately 70 percent, many types of particles exhibit deliquescent behavior and grow into fog droplets." Such droplets may absorb SO_2 prior to its catalytic oxidation.

s. Hourly pollutant concentrations from each stack are added to yield total concentrations at each grid pointfor each hour (the program can also be modified to examine simultaneously the impact of only part of a plant if special regulations apply).

t. Running three hour average pollutant concentrations are then computed by the program and reported in any one of a variety of formats. These three hour running concentrations are calculated according to the following equation:

$$_3X_i = \frac{X_{i-2} + X_{i-1} + X_i}{3}$$

where:

X_i = the 3-hour running average concentration ending inclusively with hour i ug/m^3

Study	Date	Relative Humidity (%)	Distance (km)	Travel Time (min)	Oxidation (%)	Reaction Rate (%/min)
TVA	8-19-60	100	14.4	108	55.5	0.749
TVA	9- 2-60	0	12.9	78	2.2	0.029
TVA	10-11-60	73	12.9	86	32.0	0.402
TVA	10-14-60	54	8.8	60	3.2	0.054
TVA	10-26-60	48	13.6	84	2.7	0.033
TVA	10-28-60	70	13.6	84	4.1	0.050
BNL	10- 8-74	51	16.1	35	2.5	0.072
BNL	10-13-74	50	16.1	30	1.5	0.050
BNL	10-14-74	57	16.1	75	1.8	0.024
BNL	10-15-74	65	16.1	35	2.4	0.070
BNL	10-15-74	65	48.3	105	3.6	0.035
BNL	11- 4-74	74	16.1	30	7.5	0.260

Data selected and evaluated so as to insure conservatism.

$$\text{From curve fitting, Reaction Rate (\%/min)} = \frac{1}{6}\exp\left[\frac{\text{Relative Humidity (\%)} - 70}{4}\right]^{1/5}$$

$$\therefore [SO_4^{=} \text{ as } H_2SO_4] = [SO_x \text{ as } SO_2] \times \frac{98}{64}\left[1 - \exp - \left(\frac{\text{Downwind Distance in km} \times \exp\left[\frac{RH-70}{4}\right]^{1/5}}{36 \times \text{Stack Top Wind in m/sec}}\right)\right]$$

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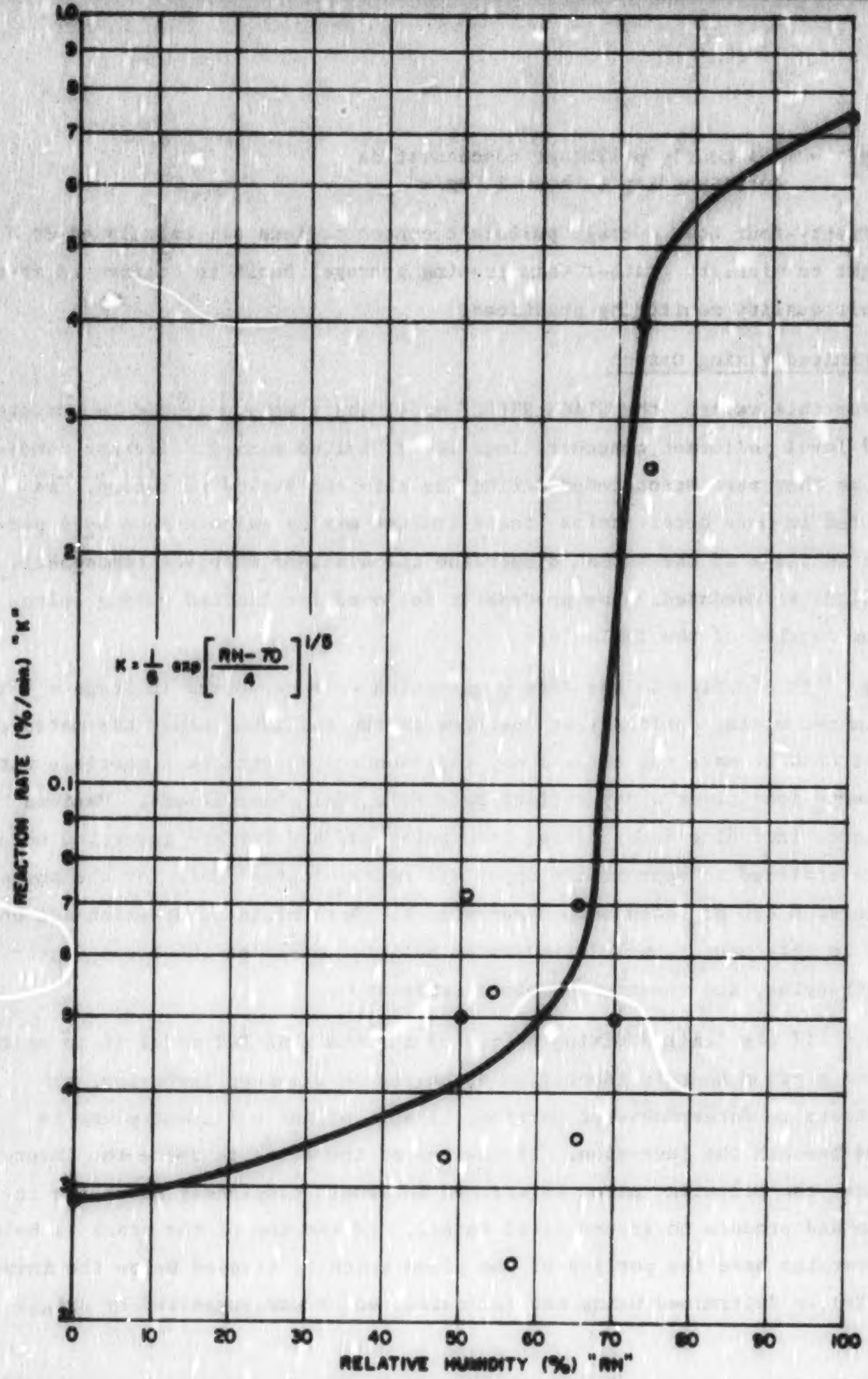
IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

RATE OF OXIDATION OF SO_2 IN COAL-FIRED POWER PLANT PLUMES

DATE:

SCALE:

TABLE
A-IV-C-1



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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

RATE OF OXIDATION OF SO_2 IN COAL-FIRED POWER PLANT PLUMES AS A FUNCTION OF RELATIVE HUMIDITY

DATE: SCALE:

EXHIBIT A-IV-C-4

X_i = the hourly pollutant concentration corresponding to hour i, ug/m^3

Twenty-four hour average pollutant concentrations are calculated on a midnight to midnight (rather than running average) basis to conform to standard air quality monitoring practices.

2. Limited Mixing Option

For this report, the STACK SELECT model was also programmed to compute ground level pollutant concentrations under limited mixing diffusion conditions as they were encountered during the examined period of record. As indicated in more detail below, these limited mixing calculations were performed in place of the normal dispersion calculations whenever atmospheric conditions so mandated. The procedures followed for limited mixing calculations consist of the following:

a. In addition to the data preparation work performed in Steps a - i, the limited mixing option first operates on the available upper air meteorological data to make the twice a day radiosonde observations compatible with the twenty-four times a day surface meteorological observations. Various techniques including persistence, interpolation, and surface inversion burn-off are utilized to approximate upper air meteorological data for the period between each set of radiosonde observations. Data of interest which are obtained in this manner include inversion height, inversion thickness, inversion strengths, and upper air ambient temperature.

b. If the limited mixing option of the STACK SELECT model is in operation and a given hour is identified as having an elevated inversion, the model tests to determine what portion, if any, of the pollutant plume is trapped beneath the inversion. If the top of the stack is above the inversion base the pollutant plume is assumed to remain completely above the inversion and produce no ground level impact. If the top of the stack is below the inversion base the portion of the plume which is trapped below the inversion (Tr) is determined using the following, which was suggested by Briggs (8,9):

$$Tr = 1.5 - \frac{\Delta h}{(L - h_s)}$$

where:

$o \leq Tr < 0.5$

and:

$Tr = 1$ for $\Delta h < (L - h_s)$

Note that when the plume centerline is not predicted to rive above the inversion base, it is assumed that the entire plume is trapped below the inversion.

c. When penetration of the lid does not occur, the impact of the inversion on ground level concentrations will not be felt until some distance from the pollutant release point. Turner has indicated that the downwind distance associated with high limited mixing concentrations can be approximated by the following relationship:

$$d = 2x$$

where:

d = downwind distance for high concentrations, m
x = downwind distance at which $o_z(x) = 0.47L$, m
L = height of inversion, m

d. Even under limited mixing conditions, the STACK SELECT model assumed that normal diffusion takes place where the diffusion plume has not reached ground level and calculates concentration accordingly until the distance from the plant specified in Step c is reached. At that point, the limited mixing diffusion equation (6) shown below is substituted for the standard diffusion equation of Step p.

$$X = \frac{Q}{\sqrt{2\pi}\ \sigma_y\ L\ u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] Tr$$

where:

X = ground level concentration of pollutant, ug/m^3
Q = pollutant release rate, ug/sec
σ_y = horizontal dispersion coefficient, m
u = stack top wind speed, mps
L = height of trapping inversion, m
y = crosswind distance plume centerline and grid point, m

e. Ground level concentrations obtained either from the limited mixing equation or the normal diffusion equation are treated identically by the model. Steps r to t (described in Subsection 1) are performed in both cases to yield the desired output information.

REFERENCES

APPENDIX A-IV-C

A-IV-C-1 Turner, D. B. 1961: "Relationships between 24-hour Mean Air Quality Measurements and Meteorological Factors in Nashville, Tennessee", *Journal of Air Pollution Control Association*, *11*, pp. 483-489.

A-IV-C-2 Personal communication; D. Bruce Turner, EPA; J. F. Silvey, Envirosphere, November 1974.

A-IV-C-3 Briggs, G. A. 1969: *Plume Rise*, U. S. Atomic Energy Commission Division of Technical Information.

A-IV-C-4 Personal communication, G. A. Briggs, (NOAA), D. B. Turner (EPA) contained in Dispersion Estimate Suggestion N. 2, Model Application Brach EPA.

A-IV-C-5 Gifford, F, A, Jr, 1972: "Atmospheric Transport and Dispersion over Cities", *Nuclear Safety*, *13*, *5*, pp. 391-399.

A-IV-C-6 Turner, D. B., 1970: *Workbook of Atmospheric Dispersion Estimates*, Environmental Protection Agency.

A-IV-C-7 Sagendorf, J. F., 1974: *A Program for Evaluating Atmospheric Dispersion from a Nuclear Power Station*, NOAA Technical Memorandum ERL ARL-42.

A-IV-C-8 Personal communication; G. A. Briggs (NOAA), A. P. Letizia, Envirosphere, April 1976.

A-IV-C-9 Briggs, G. A., 1975: "Plume Rise Predictions", in *Lectures on Air Pollution and Environmental Impact Analysis*, American Meteorological Society, Boston, Massachusetts.

Section A-IV-F

This section contains the zoning regulations for unincorporated areas of Woodbury County, Iowa. This supplements information provides in Section IV-F of the Environmental Impact Statement.

APPENDIX A-IV-F

WOODBURY COUNTY ZONING REGULATIONS

UNINCORPORATED AREAS

SECTION 10. FPC DISTRICT REGULATIONS (Floodplain and Conservation Districts).

Statement of Intent. The FPC District is intended to preserve and protect the heavily wooded areas of the County as well as the major river banks and flood plains from adverse future development. It is also intended that development of the flood plains be restricted to minimize the danger to life and property which results from development undertaken without full realization of such danger.

A. Principal Permitted Uses. Only the use of structures or land listed in this section shall be permitted in the FPC District.

1. Agriculture, truck gradening and nurseries, and the usual accessory buildings; but not including commercial livestock feed lots or poultry farms; provided that no permanent dwelling unit shall be erected thereon unless the tract contains five (5) or more acres.

2. Forests and forestry.

3. Publicly owned parks, playgrounds, golf courses, and recreational uses.

4. Any use erected or maintained by a public agency.

5. Private recreational uses including guest ranches, hunting, fishing and skiing resorts and camps; boat docks and marinas; provided however, that water supply and sewage collection and disposal systems shall meet all of the requirements of the Iowa State Health Department and the Iowa Water Pollution Control Commission.

6. Mining and extraction of minerals and raw materials; subject to approval of the Board of Adjustment including plans for final site treatment; provided that in areas subject to flooding prior approval is obtained from the Iowa Natural Resources Council.

7. Public utility structures.

8. Dumping of non-combustible materials for land fill purposes; subject to prior approval of the Iowa Natural Resources Council.

B. Permitted Accessory Uses.

1. Accessory uses customarily incidental to a permitted principal use.

2. Cabin and motel facilities, restaurants and gift shops where accessory to a permitted principal use.

3. Bulletin boards and signs appertaining to the use of the premises or to the lease, hire or sale of a building or premises, or signs appertaining to any material that is mined, grown, or treated within the District; provided however, that such signs shall not exceed 10 square feet in area.

4. Outdoor music festivals and concerts, provided that any assembly of more than 200 persons shall not be permitted without prior approval of the Board of Adjustment.

C. Bulk Regulations. The following minimum requirements shall be observed in the FPC District.

1. Front Yard: 100 feet.
2. Side Yards: Two side yards, not less than 50 feet each.
3. Rear Yard: 100 feet.
4. Maximum Height: No limitation.
5. Maximum Number of Stories: No limitation

D. Off-Street Parking and Loading. Spaces for off-street parking and loading shall be provided in sufficient number to accomodate the permitted uses and shall not encroach on any public right-of-way.

SECTION 11. AR DISTRICT REGULATIONS (Agricultural-Residential Districts).

Statement of Intent. The AR District is intended and designed to provide for low density residential development in conjunction with agriculture.

A. Principal Permitted Uses. Only the use of structures or land listed in this section shall be permitted in the AR District.

1. One and two-family dwellings.

2. Agriculture and the usual agricultural buildings and structures, including nurseries and truck gardens; but not including commercial livestock feed lots and poultry farms.

3. Churches, chapels, temples, and similar places of worship; provided that all principal buildings be set back a minimum of fifty (50) feet from all property lines.

4. Public and parochial schools, elementary and secondary, and colleges and universities; provided that all principal buildings be set back a minimum of fifty (50) feet from all property lines.

SECTION 18: MH DISTRICT REGULATIONS (Heavy Industrial Districts)

Statement of Intent. The MH District is intended and designed to provide areas of the County for activities and uses of a heavy industrial character. Since this is the least restrict of any district, almost any use is permissible which does not conflict with other ordinances or regulations of Woodbury County or the State of Iowa. In addition, no residential uses are permitted except farm dwellings in areas used for agriculture.

A. Principal Permitted Uses. A building or premises may be used FOR ANY PURPOSE whatsoever provided the regulations listed in subparagraphs 1, 2 and 3 below are met:

1. No zoning certificate shall be issued for any use in conflict with any ordinance of Woodbury County or law of the State of Iowa regulating nuisances.

2. No zoning certificate should be issued for any dwelling, school, hospital, clinic or other institution for human care except where incidental to a permitted principal use.

3. The following uses and uses of a like or similar nature shall be considered permitted principal uses only in the MH District:

   a. Abattoirs, slaughter houses, meat packing plants and stock yards.
   b. Acid manufacture or wholesale storage of acids.
   c. Anhydrous ammonia storage.
   d. Automobile, tractor or machinery wrecking and usedpart yards; provided that any wrecking operation is carried on within a building completely enclosed with walls and roof or within a yard completely enclosed with a wall or fence, reasonably maintained, at least six (6) feet high completely obscuring the activity. Said wall or fence need be no higher than fifteen (15) feet, in any event. There shall be only one opening in the wall or fence facing any public street for each two hundred (200) feet of length.
   e. Cement, lime, gypsum or plaster of paris manufacture.
   f. Distillation of bones.
   g. Explosive manufacture or storage.
   h. Fat rendering
   i. Fertilizer manufacture.
   j. Garbage, offal or deal animal reduction or dumping.
   k. Gas manufacture and cylinder recharging.
   l. Glue, size or gelatin manufacture.
   m. Junk, iron or rags, storage or baling, and wastepaper yards, where the premises upon which such activities are conducted are wholly enclosed within a building, wall or fence not less than six (6) feet in height, completely obscuring the activity.
   n. Petroleum or its products, refining or wholesale storage of, and asphalt plants.
   o. Rubber goods manufacture.
   p. Smelting of tin, copper, zinc or iron ores.
   q. Transmitting stations.

r. Wholesale storage of gasoline or other flammable liquids.

B. Required Conditions.

1. The best practical means available for the disposal of refuse matter or water-carried waste the abatement of obnoxious or offensive order, dust,smoke, gas, noise, or similar nuisance, shall be employed.

2. All facilities required for the discharge, collection and treatment of liquid, solid or gaseous wastes shall be designed, constructed and operated in accordance with the regulations of the Iowa Water Pollution Control Commission and the Iowa Air Pollution Control Commission.

3. All principal or accessory structures housing a use permitted only in the MH District shall be located at least two hundred (200) feet from any "AR", "FPC" or "R" District boundary.

C. Bulk Regulations. The Following minimum requirements shall be observed subject to the modifications contained in Section 21.

1.	Front Yard	100 feet.
2.	Side Yards:	None required, except when adjacent to any street right-of-way line, in which case twenty-five (25) feet.
3.	Rear Yard:	Fifty (50) feet, except that where a railroad right-of-way lies immediately adjacent to the rear of a lot, the rear of a lot, the rear yard requirement need not apply.
4.	Maximum Height:	No limitation; provided, however, that no structure shall be permitted to extend into the approach zones, clear zones or other restricted air space required for the protection of any public airport.
5.	Maximum Number of Stories:	No limitation.

D. Off-street Parking and Loading. Spaces for off-street parking and loading shall be provided in accordance with the provisions of Sections 19 and 20.

Section A-V-C

This section contains a discussion of the evaluation methods used in the Neal Unit 4 alternative cooling water system study. This supplements information provided in Section V-C of the Environmental Impact Statement.

APPENDIX A-V-C

EVALUATION METHODS FOR ALTERNATIVE COOLING SYSTEMS

1. SALT DEPOSITION MODEL

Cooling towers dissipate waste heat to the atmosphere by latent and sensible heat transfer. Both water vapor and droplets are emitted from the tower. Although the quantity of droplets (drift) can be minimized, the chemical content of the drift droplets must be considered in evaluating cooling tower environmental effects.

The downwind deposition of salt is mainly dependent upon:

☐ The characteristics of the cooling water;

☐ The mass and drop size distribution of the drift;

☐ The chemical content of the drift droplets; and,

☐ The ambient relative humidity, wind speed and turbulence characteristics.

Cooling tower characteristics and the drift drop spectrum determine how high the drops are carried by the momentum and buoyancy forces within the cooling tower plume. The chemical content of the drift droplets and the ambient relative humidity determine the change in drop size and subsequent settling velocity. Wind speed determines the horizontal dispersion of the drift, and atmospheric turbulence determines the rate of deposition of salt at ground level.

Table A-V-C-1 presents the pertinent characteristics of the natural draft and round mechanical draft cooling towers evaluated in the study. The cumulative frequencies of the percent of total water mass of drift contributed by each of five drift droplet sizes used in the model for natural draft and round mechanical draft cooling tower salt deposition are as follows:

Natural Draft Cooling Tower		Round Mechanical Draft Cooling Tower	
Drop Radius (u)	Cum Freq (Percent)	Drop Radius (u)	Cum Freq (Percent)
15	0	11	0
90	82	169	6
112	86	328	39
162	94	487	71
250	100	645	100

The rate of salt emitted from the cooling towers was calculated by the equation:

$$Q = FC\rho DS \qquad (1)$$

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Parameter	Natural Draft	Mechanical Draft
Design dry bulb temperature (F)	89.0	89.0
Design wet bulb temperature (F)	77	77
Design relative humidity (percent)	59.1	59.1
Height (feet)	350.0	62.0
Top diameter (feet)	160.0	315.0
Configuration	1 tower	1 tower 12 cells
Condenser rise (F)	17	17
Exit air volume (ft^3/hr)	9.7×10^8	1.0×10^9
Exit velocity (ft/sec)	13.3	38.5
L/G ratio	2.6	2.4
Unit rating (MW)	640	640
Heat rate (Btu/hr)	2.7×10^9	2.7×10^9
Load factor (percent)	100	100
Drift rate (percent)	0.005	0.010
Total dissolved salts (ppm)	2500	2500
Condenser cooling water (gpm)	3.17×10^5	3.17×10^5

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

NATURAL DRAFT AND ROUND MECHANICAL DRAFT COOLING TOWER CHARACTERISTICS

DATE:
SCALE:

TABLE A-V-C-1

R_o = initial radius of plume (cm)

T_{vpo} = initial virtual temperature of plume (°K)

T_{veo} = initial virtual temperature of environment (°K)

q_{po} = initial specific humidity of the plume (gm vapor/gm air)

q_{eo} = initial specific humidity of the environment (gm vapor/gm air)

L = latent heat required to evaporate one gram of water (cal/gm vapor)

C_p = specific heat of air at constant pressure (cal/gm air °K)

T_{po} = initial temperature of plume (°K)

This flux considers the increase in buoyancy due to the condensation of excess water vapor. It was assumed that one-half of the excess water vapor condenses during the plume rise; the second term in the brackets in Equation (3) was therefore multiplied by 0.5. The following values of seasonal potential temperature gradient ($d\phi/dz$) were used in Equation (2):

Season	$d\phi/dz$ (degrees centigrade/100 meters)
spring	0.79
summer	0.73
autumn	0.88
winter	0.91

All the condensed water is assumed to fall out of the plume.

The computerized model used for the calculation of ground level salt deposition rates considers the drop dynamics of each drift droplet size group separately for varying meteorological conditions.[3/] Eight years of hourly weather data (1959-1966) from the National Weather Service office at the Sioux City Municipal Airport were used to construct monthly joint frequency tables of temperature, relative humidity and wind speed for each of 16 wind directions. These weather data determine which of the following three situations most accurately represents the final state of the falling drift droplets:

☐ The droplets fall with no change in size;

☐ The droplets evaporate to a saturated state; and,

☐ The droplets evaporate to dry salt particles.

The downwind transport of the drift is determined by the ambient wind speed and the height to which the droplets are carried by the cooling tower plume. The droplets are where:

Q = salt emission per tower (Lb/hr)

F = plant load factor (percent)

ρ = density of the saline water (Lb/gal)

D = drift (percent)

S = salinity of circulating water (percent)

Calculated values of salt emission by use of Equation (1) are about 20 Lb/hr and 40 Lb/hr for natural draft and round mechanical cooling towers, respectively.

The plume rise resulting from the buoyant tower exhaust was calculated by an equation by Hanna.[1] According to Briggs[2] the final rise of dry plumes in a stable atmosphere under windy conditions can be estimated by:

$$H = 2.9(F_o/US)^{1/3} \tag{2}$$

where:

F_o = the initial flux of buoyancy (cm^4/sec^3)

U = wind speed (cm/sec)

S = a stability parameter (sec^{-2})

where:

$$S = \frac{g}{T_p} \times \frac{d\phi}{dz}$$

and: g = acceleration of gravity (cm/sec^2)

T_p = temperature of plume (°C)

$\frac{d\phi}{dz}$ = potential temperature gradient (°C/cm)

The buoyancy flux in the plume is given by Hanna as:

$$F_o = gW_oR_o^2 \left[\frac{T_{vpo} - T_{veo}}{T_{vpo}} \left(q_{po} - q_{eo}\right) \frac{L}{C_pT_{po}}\right] \tag{3}$$

where:

W_o = initial vertical speed of plume (cm/sec) assumed to leave the plume when their fall velocities become equal to the vertical velocity within the plume. Implicit within the model is the assumption that gravitational settling is the primary mechanism for deposition.

Weather data were stratified into four three-month seasons and average salt deposition rates determined for each season during the eight year period. Each of the four sets of seasonal deposition rates utilizes hourly meteorological conditions and gives centerline deposition values directly downwind from the cooling tower. Results for the spring season are given in Exhibits A-V-C-1 and A-V-C-2.

2. NATURAL DRAFT COOLING TOWER FOGGING MODEL

The length of the visible plume emitted from the natural draft cooling tower was calculated using Baker's Equation:[4]

$$X_P = 5.7 \left[\frac{G}{102\ V} \right]^{1/2} \left[\frac{T_E - T_I}{T_P - T_I} - 1.0 \right]^{1/2} \qquad (4)$$

where:

X_P = visible plume length (feet)

G = total vapor rate from tower (m^3/hr)

V = wind speed (feet/sec)

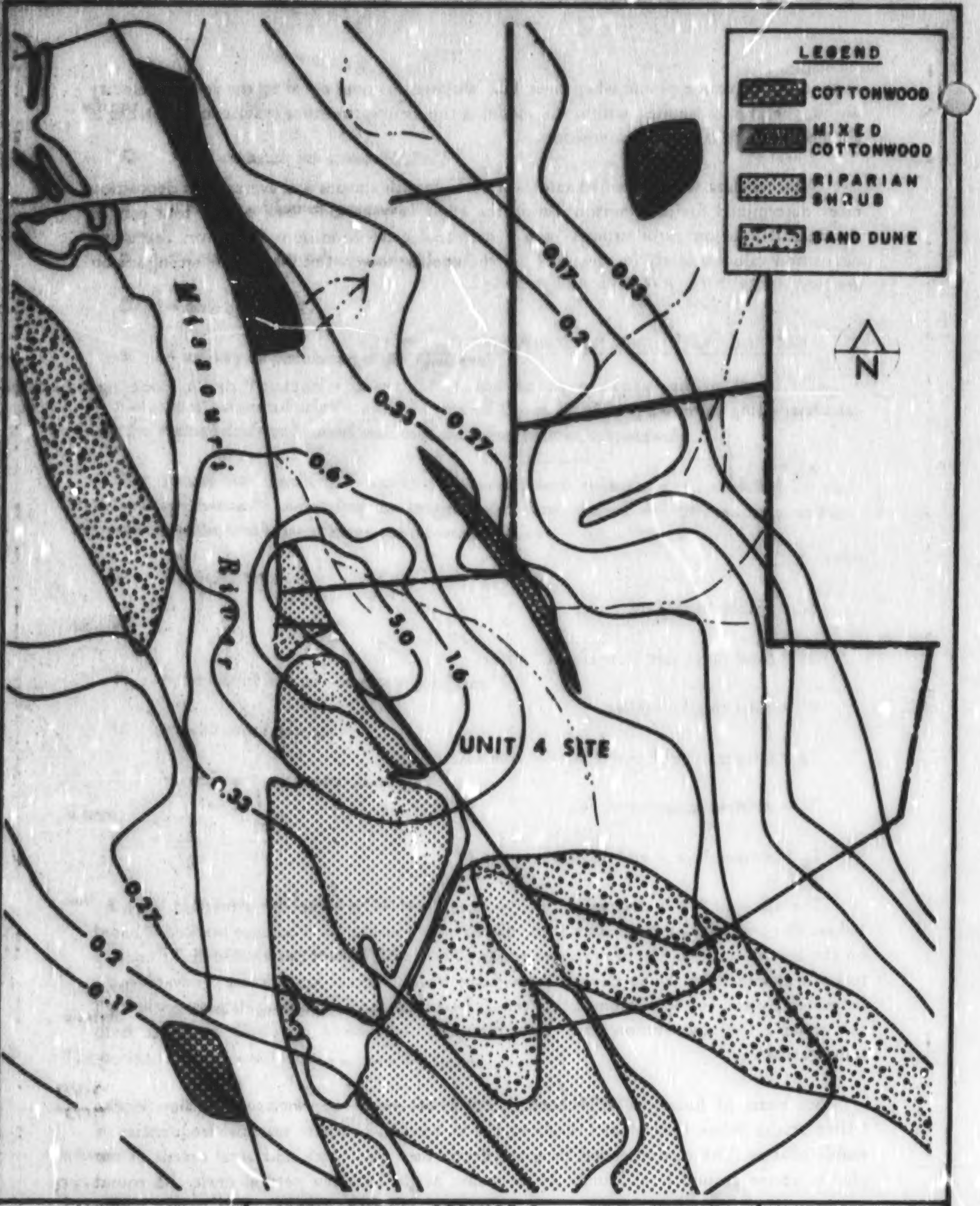
T_E = temperature of plume at exit from tower (C)

T_I = ambient temperature (C)

T_P = temperature at end of visible plume (C)

The value of T_P is determined in the computerized program by a method given by Baker. The exit plume temperature is calculated by a heat-and-mass balance method[5] based on the law of conservation of mass and energy. The mass of water evaporated in the cooling tower is absorbed by the air flowing through the tower, and the heat lost by the water must be gained by the air. It is assumed that the air becomes saturated during its passage through the tower. The evaporation rate is a function of ambient dry bulb and wet bulb temperatures.

Six years of hourly weather data (1959-1964) from the National Weather Service Office at the Sioux City Municipal Airport were used to compute seasonal frequencies of visible plumes. The computerized program determines the length and areal extent of the plumes above ground level. Similarity in plume height between natural draft and round mechanical draft cooling towers, however, indicates that the frequency of visible plume formation would be similar to the round cooling towers. Results are given in Table A-V-C-2.


LEGEND
COTTONWOOD
MIXED COTTONWOOD
RIPARIAN SHRUB
SAND DUNE
N
Missouri River
UNIT 4 SITE
0.17
0.13
0.2
0.33
0.27
0.67
3.0
1.6
0.33
0.27
0.2
0.17

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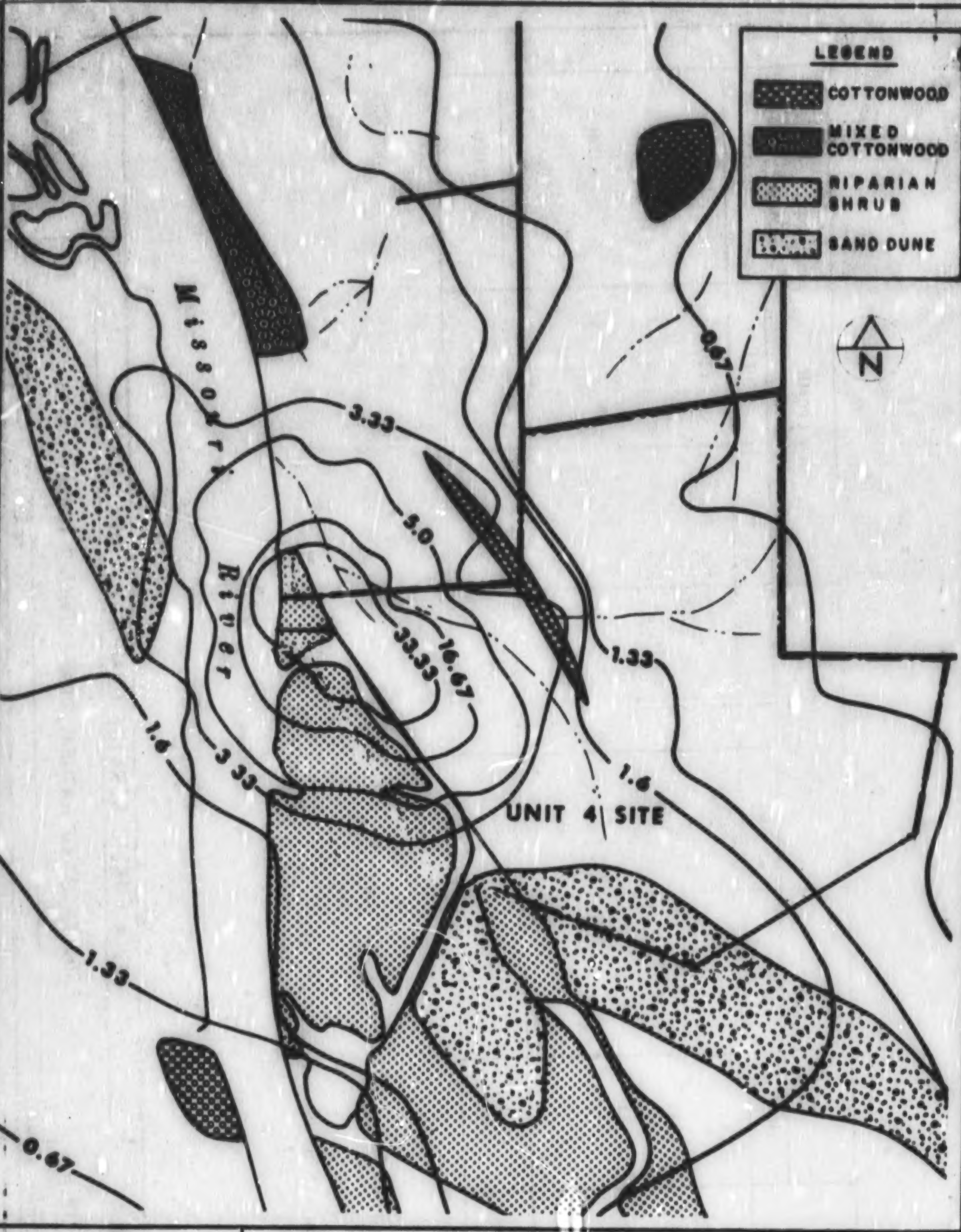
IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PREDICTED SALT DEPOSITION, NATURAL DRAFT COOLING TOWER - SPRING SEASON (LBS/ACRE/MONTH)

DATE:

SCALE:

EXHIBIT A-V-C-1


LEGEND
COTTONWOOD
MIXED COTTONWOOD
RIPARIAN SHRUB
SAND DUNE
N
Missouri River
0.67
3.33
5.0
33.33
16.67
1.33
1.6
3.33
1.6
1.33
0.67
UNIT 4 SITE

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IOWA PUBLIC SERVICE Co. - NEAL UNIT 4

PREDICTED SALT DEPOSITION, ROUND
MECHANICAL DRAFT COOLING TOWER
SPRING SEASON (LBS/ACRE/MONTH)

DATE:
SCALE:

EXHIBIT
A-V-C-2

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Season[a]	No Plume		Plume Length < 1000 ft		Plume Length > 1000 ft		Maximum Length (Ft)
	Hrs	Freq (%)	Hrs	Freq (%)	Hrs	Freq (%)	
Spring	1339	61	552	25	300	14	10.000
Summer	1737	80	361	16	93	4	7.000
Fall	1254	58	661	30	276	12	8.000
Winter	398	18	986	45	807	37	10.000
Annual[b]	4730	55	2560	29	1475	16	10.000

[a] Based on 2191 observations per season, 1959–1964.

[b] Based on 8765 observations, 1959–1964.

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

FREQUENCIES OF NATURAL DRAFT COOLING TOWER PLUMES

DATE:

SCALE:

TABLE A-V-C-2

3. MECHANICAL DRAFT COOLING TOWER FOGGING MODEL

The modeling of cooling tower induced ground fog is based on the following assumptions:

- ☐ The evaporative water rate from the cooling tower is calculated as a function of hourly meteorological parameters;
- ☐ The cooling system is assumed to saturate the ambient air that is drawn through the cooling towers;
- ☐ The release height of the vapor is a function of cooling tower height, plume buoyancy (which includes the effect of latent heat of vaporization), and momentum, as reflected in Hanna's plume rise equation (Equation 3);
- ☐ The plume spread has a Gaussian distribution in both the horizontal and vertical planes;
- ☐ Periods with visibilities less than 0.5 miles due to naturally occurring fog were discontinued as periods of cooling tower induced fogging; and,
- ☐ Periods with 100 percent relative humidity but visibilities greater than or equal to 0.5 mile were counted as periods of cooling tower induced fog

The transport of cooling tower water vapor is primarily governed by the horizontal wind velocity, stability and moisture distribution in the lower layers of the atmosphere. The ground level concentrations of water vapor directly downwind of a tower can be estimated by the Gaussian diffusion equation:[6]

$$X = \frac{Q}{\pi \sigma_y \sigma_z \bar{u}} \text{ EXP } \left[-0.5 \left(\frac{h}{\sigma_z} \right)^2 \right] \tag{5}$$

where:

X = water vapor density at a given downwind distance from the tower (gm/m^3)

Q = vapor release rate from a tower (gm/sec)

σ_y = horizontal plume standard deviation (m)

σ_z = vertical plume standard deviation (m)

$\bar{u}$ = mean wind speed at release height (m/sec)

h = effective tower height (m)

The effective cooling tower height is the height of the plume centerline when its trajectory becomes essentially horizontal. It is the sum of the actual cooling tower height and the plume rise. The plume rise resulting from the buoyant cooling tower exhaust was calculated by an equation developed by Hanna (discussed previously).

Equation (5) was used to calculate hourly water vapor concentrations for each season during the 1959-1964 period. Hourly meteorological data were used to compute the areal ground level water vapor concentrations. These concentrations were then compared with the ambient saturation deficit to determine the frequency of cooling tower induced fog in the plant vicinity. The saturation deficit is the difference between the mass of water vapor required to saturate a unit volume of air (to 100 percent relative humidity) and the given mass of ambient water vapor. If the computed water vapor concentration was greater than or equal to the saturation deficit, a tower induced fog was assumed to form.

The computerized program also calculates the seasonal frequency of natural fog and cooling tower induced icing. Natural fog was assumed to exist when the visibility was less than 0.5 mile, and cooling tower induced icing was expected to occur when criteria were met for cooling tower induced fogging but the ambient temperature was 32 F or less. Results are given in Table A-V-C-3.

4. TERRESTRIAL ECOLOGY IMPACT CRITERIA

The evaluation of cooling water system impacts on terrestrial communities is based on consideration of effects on vegetation attendant with cooling tower operation. Recent investigations have been conducted to determine these effects, but only problems primarily associated with salt water cooling towers have been addressed. The evaluation criteria discussed in this section are developed from pertinent information derived from these investigations and include studies of plant responses to ocean spray, road deicing, and laboratory salt exposures.

The deposition of salt particles from the cooling tower plume constitutes the major impact of a cooling water system on terrestrial communities. Recent research reports have emphasized that a complete assessment of the impact requires more information on the effects of aerial salt deposition on plant leaves than is presently available. 7/, 8/, 9/ Aerial impaction promotes rapid foliar uptake of the ions which are in solution on the leaf surfaces, and can eventually result in abnormally high ion concentrations in plant tissue. A determination of the rate of aerial deposition which could expose vegetation to toxic levels is presented below. It is important to note that aerial salt deposition on plant leaves is a process not normally associated with agricultural irrigation for which literature reports on the relationship between soil salinity and crop yield are available.

Addition of sufficient quantities of salt, regardless of chemical composition, to the environment can depress the water potential of the soil below the lowest level attainable by plant roots (permanent wilting point) and thereby prevent further water absorption. 10/ A significant partial depression of soil water potential effects a growth rate reduction in most plants, a process which continues as moisture availability decreases. 11/

The degree to which an amount of aerially deposited salt increases salinity (with a corresponding decrease in moisture availability) is determined largely by drainage conditions

Season[a]	Natural Fog All Distances From Tower		Cooling-Tower-Induced Fog						Direction of Maximum Frequency
			1.5 km from tower		10.0 km from tower		>10.0 km from tower		
	Hrs	Freq (%)	Hrs	Freq (%)	Hrs	Freq (%)	Hrs	Freq (%)	
Winter	55.0	2.5	0.4	1.0	34.0	1.6	37.0	1.7	NNW
Spring	18.0	1.0	2.5	1.0	39.0	1.8	42.0	1.9	WNW
Summer	7.0	1.0	0.2	1.0	13.0	1.0	15.0	1.0	W
Fall	20.0	1.0	1.1	1.0	27.0	1.2	33.0	1.5	NW
Annual[b]	10.0	1.1	4.2	1.0	113	1.3	127	1.4	NW

a. Seasonal data are based on 2191 observations per season, 1959 1964.

b. Annual data based on 8765 observations, 1959 1964.

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IOWA PUBLIC SERVICE COMPANY - NEAL UNIT 4

FREQUENCIES OF ROUND MECHANICAL DRAFT COOLING TOWER GROUND FOG

DATE:

SCALE:

TABLE A-V-C-3

and climate. Adequately drained soils in regions with precipitation sufficient to leach soluble salts into the ground water system do not generally exhibit high salinities. Saline soils can develop, however, in areas of poor drainage or with water tables located within five or six feet of the ground surface.[12]

Salt deposition rates required to alter soil salinity in the vicinity of Neal Unit 4, therefore, depend on local drainage and leaching conditions. If irrigation water concentrated with dissolved salts is not evaporated or trapped near the ground surface, some agricultural lands can receive as much as 50 000 lbs salt/acre/year (4166 lb salt/acre/month).[12] Application of 53 lbs sodium chloride/acre/month to well-drained sandy loam soil in Maryland has been observed to effect moderate increases in ground surface sodium concentration; whether increases of this ion would continue over several years of salt deposition has not been determined. Naturally occurring saline areas were originally widespread along the Missouri River floodplain valley[13], indicating that even small rates of salt deposition may affect soil salinity in certain areas of this region.

Abnormally large concentrations of any soil element can adversely affect plant health.[14] Ions such as chloride and sodium elicit specific responses from plants when present in the soil or tissue in amounts exceeding threshold levels. These levels vary widely between both elements and species. Mechanisms of specific toxicity are little understood, although interference with mineral and nutrient uptake and with enzyme activity are believed to be major factors.[15] Cooling towers at Neal Unit 4 would emit salts with chemical compositions determined by elements found in the makeup water and by any substance purposely added to the circulating water. Calcium and sulfate ions would predominate in Neal Unit 4 tower salts, rather than sodium and chloride which are the major ions deposited by cooling towers relying on ocean water.

Preliminary calculations indicate that sulfate could comprise as much as seventy-five percent of the salts emanating from a cooling tower at Neal Unit 4. If present in sufficiently high concentrations, this ion can injure plants through possible inhibition of calcium and molybdenum uptake[11], [16], or through accumulation in leaf tissue and development of chlorotic patches.[17], [18] Because this ion is not commonly associated with incidences of specific toxicity to agricultural crops, concentrations required to cause damage have not been determined and presumably would vary between species. Sulfate solutions are rapidly absorbed through leaf surfaces[19]; aerial deposition concomitant with high humidities or light rains, could, therefore, effect an increase in vegetation sulfur content.

Erosion, leaching processes, and the harvesting of crops which require large amounts of sulfur such as alfalfa, soybeans, and sorghum, can remove 30 lbs sulfur/acre/year. To meet agricultural needs, farmers can rely on precipitation to add to the ground 3 to 100 lbs sulfur/acre/year.[16] Retention of the soluble sulfate ion in surface soil is usually slight or not detectable when pH values range higher than 6.0 to 6.5.[20]

Symptoms of toxicity arising from excessive absorption of sodium and chloride are similar and generally consist of necrotic tissue on leaf tips and margins.[21], [22] Few studies have actually documented the specific effects of sodium, while chloride has been identified as the probable toxic agent in experiments where foliar damage resulted from applications of sea spray or road salt.[23], [24] This anion can also depress growth rate in some species.[25] Weekly exposure of young soybean plants to concentrated sodium chloride spray at the rate of 26.48 lbs/acre/month produced extensive visible leaf injury (necrosis). While still receiving salt spray treatment, plants regained near normal coloring through compensatory foliar growth, although final crop yield was reduced by 13.3 percent. Exposure to 13.24 lbs/acre/month produced neither abnormal effects nor reduction in yield. Corn plants evidenced a 10.5 percent reduction in yield from exposure to salt spray rates as low as 6.60 lbs/acre/month. Rates of at least 26.28 lbs/acre/month were required, however, to evoke leaf damage (extreme chlorosis). Foliar injury increased throughout the summer without signs of recovery, indicating that, unlike alfalfa, the early growth stage of corn is not more susceptible to salt spray than later stages. In all cases high concentrations of tissue chloride accompanied symptoms of toxicity and growth reduction.[9]

Tobacco has been found to be more sensitive than most plants to chloride, with deposition rates of 1.2 to 17.4 chlorine lbs/acre/month altering curing properties.[8] For this reason, salt water cooling towers in Maryland are designed to deposit less than 35 lbs salt/acre/year in agricultural regions, and 100 lbs salt/acre/year in industrial zones.[26]

5. ENGINEERING COST ANALYSIS

The economic evaluation of the alternative condenser cooling water systems for Neal Unit 4 is based on the total generating cost (present worth) associated with each alternative system. Estimates of the initial capital investment cost associated with each alternative system were prepared based on conceptual system designs developed from preliminary plot plans and plant operating characteristics. Included in these estimates are the major civil, mechanical and electrical components of each system exclusive of the condenser. The estimates were escalated to the base year 1977, representative of the Neal Unit 4 construction schedule, and include Sales/Use Taxes, Indirect Construction Cost, Contingencies, and Home Office Services and Fees.

The total generating cost (present worth) was developed from the initial capital investment cost and annual operating, fuel, and maintenance costs. For each alternative system, a fixed charge rate of 15 percent was applied against the initial capital investment cost to obtain an equivalent annual cost over an assumed 30 year plant life. The fixed charge rate includes return on investment, insurance, taxes and depreciation. An annual penalty was applied to each alternative system based on a fuel cost of $0.76 per million Btu (mB). This is the fuel cost associated with the generating power required to operate the respective cooling water system. An annual capacity loss penalty was also applied to each alternative. This represents the cost associated with building into the unit the generating power lost through the operation of the respective cooling water systems in order to meet the necessary system load requirements. With the inclusion of an annual maintenance cost, the development of the total generating cost (annualized) for each alternative cooling water system is completed.

The total generating cost (annualized) represents the yearly cash outlay allocated for each alternative system over the estimated 30 year life of the power plant. The present worth of the total generating cost (annualized) would represent the total generating cost (present worth) in 1977 dollars required for each alternative cooling water system over the expected life of the plant.

Using this approach, the total generating cost (present worth) and total generating cost (annualized) for the selected once-through condenser cooling system are, respectively, $23 416 000 and $1 887 000. Similar estimates have been prepared for the alternative cooling systems and are presented subsequently as absolute costs and as differential costs relative to the once-through system cost.

As previously stated, the cost estimates prepared for the condenser cooling water system were based on conceptual system designs developed from preliminary plot plans and plant operating characteristics. Consequently, these estimates, although sufficient for ranking the alternative systems, may not represent the precise cost of each system as constructed on the site.

REFERENCES

A-V-C - EVALUATION METHODS FOR ALTERNATIVE COOLING SYSTEMS

A-V-C-1 Hanna, S R, "Rise and Condensation of Large Cooling Tower Plumes," Journal of Applied Meteorology, Vol. II, August 1972, p. 793-799.

A-V-C-2 Briggs, G A, "Plume Rise", AEC Critical Review Series, TID-25075, National Technical Information Service, Springfield, Virginia, November 1969, p. 55.

A-V-C-3 Hosler, C, et al, "Determination of Salt Deposition Rates from Drift From Evaporative Cooling Towers," Pennsylvania State University, May 1972, p. 42.

A-V-C-4 Baker, K G, "Water Cooling Tower Plumes," Chemical and Engineering Process, January, 1967, p. 56-58.

A-V-C-5 Leung, P and R E Moore, "Water Consumption Determination for Steam Power Plant Cooling Towers – A Heat and Mass Balance Method," Bechtel Corporation, November, 1970, p. 14-23.

A-V-C-6 Turner, D B, "Workbook of Atmospheric Dispersion Estimates," Office of Air Programs, Environmental Protection Agency, Research Triangle Park, North Carolina, July 1971, p.6.

A-V-C-7 Addendum to Power Plant Site Evaluation, Brandon Shores Site (PPSE 1-2), the John Hopkins University Applied Physics Laboratory, Chesapeake Bay Institute, and Department of Geography and Environmental Engineering, Jan. 18, 1973.

A-V-C-8 Roffman, A. 1973. The State of the Art of Saltwater Cooling Towers for Steam Electric Generating Plants. Westinghouse Electric Corp.

A-V-C-9 Mulchi, C L and J A Armbruster. 1974. Effects of salt sprays on the yield and nutrient balance of corn (Zea mays, L) and soybeans (Glycine max., L). Draft of paper presented at the Cooling Tower Environment – 1974 Symposium, University of Maryland, College Park, Maryland, March 4-6, 1974.

A-V-C-10 Salisbury, F B, and C Ross. 1969. Plant Physiology, (Wadsworth Publishing Co., Inc., Belmont, California).

A-V-C-11 United States Salinity Laboratory. 1954. Diagnosis and Improvement of Saline and Alkali Soils. Agricultural Handbook No. 60.

A-V-C-12 Bower, C A, M Fiereman. 1957. Saline and alkali soils, in Soil, the Yearbook of Agriculture, 1957. USDA

A-V-C-13 Weaver, J E 1960. Floodplain vegetation of the central Missouri Valley and contacts of woodland with prairie. Ecological Monographs 30: 37-64.

A-V-C-14 Bear, F E 1957. Toxic elements in soils, in Soil, the Yearbook of Agriculture, 1957. United States Department of Agriculture.

A-V-C-15 Stucliffe, J F. 1962. Mineral Salts Absorption in Plants, (Pergamon Press, N.Y.).

A-V-C-16 Buckman, H O and N C Brady. 1969. The Nature and Properties of Soils. (Macmillan Corp. N.Y.).

A-V-C-17 Hindawi, I A. 1970. Air pollution injury to vegetation. National Air Pollution Control Administration Publication. No. AP-71.

A-V-C-18 Dochinger, L S. 1972. Impact of air pollution on forest tree plantings. Proceedings of the 27th Annual Meeting of the Soil Conservation Society of America, August 6-7, 1972. Portland, Oregon.

A-V-C-19 Wittwer, S H and F G Teubner. 1959. Foliar absorption of mineral nutrients. Annual Review of Plant Physiology 10: 13-32.

A-V-C-20 Fried, M and H Broeshart. 1967. The Soil Plant System, (Academic Press, N.Y.).

A-V-C-21 Lacasse, N L and W J Moroz. 1969. Vegetation Damage. Center for Air Environment Studies, Pennsylvania State University, University Park, Pennsylvania.

A-V-C-22 Martin, W E. 1959. The vegetation of Island Beach State Park, N.J. Ecological Monographs 29 (1): 1-46.

A-V-C-23 Moser, B C and R L Swain. 1971. Potential effects of salt drift on vegetation. Report to Jersey Central Power and Light Company (mimeo).

A-V-C-24 Holmes, F W. 1961. Salt injury to trees. Phytopathology 51: 712-718.

A-V-C-25 Hayward, H E and L Bernstein. 1958. Plant growth relationships on salt affected soils. Botanical Review 24: 584-635.

A-V-C-26 Johns Hopkins University, Applied Physics Laboratory. 1974. Power Plant Site Evaluation 4-1, Douglas Point Site, May, 1974.

A-V-C-27 Stout, P R and C M Johnson. 1957. Trace element in Soil, The Yearbook of Agriculture, 1957. USDA.

A-V-C-28 Jordan, H U and H M Reisenauer. 1957. Sulfur and soil fertility, in Soil, the Yearbook of Agriculture, 1957. USDA.